

DESIGNING FRAMEWORK FOR HUMAN RESOURCE ON-BOARDING AND OFF-BOARDING PRACTICES USING BLOCKCHAIN TECHNOLOGY IN SELECT SECTOR

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Management

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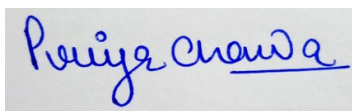
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2025

Declaration

I, hereby declare that the presented work in the thesis entitled “**Designing Framework for Human Resource On-Boarding and Off-Boarding Practices using Blockchain Technology in Select Sector**” in fulfillment of the degree of **Doctor of Philosophy (Ph. D.)** is the outcome of research work carried out by me under the supervision of **Dr. Pritpal Singh**, working as **Professor**, in the **Mittal School of Business** of Lovely Professional University, Punjab, India. In keeping with the general practice of reporting scientific observations, due acknowledgments have been made whenever the work described here has been based on the findings of other investigators. This work has not been submitted in part or full to any other University or Institute for the award of any degree.



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Certificate

This is to certify that the work reported in the Ph. D. thesis entitled “**Designing Framework for Human Resource On-Boarding and Off-Boarding Practices using Blockchain Technology in Select Sector**” submitted in fulfillment of the requirement for the award of degree of **Doctor of Philosophy (Ph.D.)** in the **Mittal School of Business**, is a research work carried out by **Priya Chanda, 12208547**, is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.



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Abstract

Human resource onboarding and offboarding processes are critical components of effective workforce management to ensure seamless transitions for employees entering and exiting an organization. Onboarding is essential to equip new employees with the knowledge, tools, and resources needed to integrate their roles and foster engagement and productivity. Conversely, offboarding ensures that departing employees leave the organization with professionalism and compliance, addressing aspects such as knowledge transfer, asset returns, and final settlements. Despite their importance, these processes often face several challenges that hinder organizational efficiency.

One significant issue in onboarding is the reliance on manual paper-based workflows, leading to inefficiencies, delays, and inconsistencies. Verifying employee credentials and completing documentation can be time-consuming, especially in industries such as automobile manufacturing, where compliance with safety and regulatory standards is critical. Similarly, offboarding faces challenges, such as incomplete clearance processes, security risks due to delayed access revocation, and insufficient attention to knowledge transfer. These inefficiencies not only disrupt operations, but also increase the risk of data breaches, non-compliance, and negative employee experience.

Blockchain technology offers a transformative solution to these challenges owing to its unique features including decentralization, immutability, and cryptographic security. Decentralization eliminates reliance on a central authority by distributing data across a network of nodes and enhancing accessibility and resilience to single points of failure. Immutability ensures that once data are recorded on blockchain technology, they cannot be altered or deleted without consensus, thus creating a tamper-proof record of all onboarding and offboarding activities. Cryptographic security protects sensitive employee information from unauthorized access, ensuring confidentiality and data integrity.

These blockchain technology features address the inefficiencies and risks inherent in traditional HR processes. For instance, onboarding documentation can be securely recorded on blockchain technology, enabling the real-time verification of credentials and compliance with regulatory requirements. Automated smart contracts streamline workflows by triggering predefined actions such as issuing access credentials or scheduling training sessions to meet specific conditions. In offboarding, blockchain technology ensures the timely revocation of system

access and provides an immutable record of clearance approvals, thereby enhancing operational security and accountability.

The blockchain technology -based onboarding and offboarding processes represent a paradigm shift in HR management. By integrating blockchain technology, organizations can enhance transparency, reduce administrative burdens, and create seamless and secure employee experience. This innovative approach not only addresses existing inefficiencies but also positions HR processes as strategic contributors to organizational success, fostering trust and efficiency in managing the employee lifecycle.

This study focuses on the following objectives:

1. To conduct a bibliometric analysis, we analyze the literature related to blockchain and human resource management.
2. Primary data analysis was performed to access the information system used for data collection.
3. To create a framework for human resources onboard and offboarding using blockchain technology.
4. The proposed framework was applied using a blockchain consensus mechanism.

This study was conducted in a manner consistent with these objectives. This thesis is divided into six chapters: A description of this thesis is as follows:

Chapter 1 serves as a foundational exploration of the pivotal concepts and themes that underpin the research, and provides a comprehensive introduction to its scope and significance. It begins by presenting an overview of the subject and emphasizing its relevance to the current technological and organizational landscape. Through a detailed examination of this background, this chapter contextualizes the research problem and highlights the pressing challenges that need to be addressed. The discussion delves into the evolution of the domain, tracing its transformation over time and underscoring the factors driving this progression. It further introduces key theoretical frameworks and emerging technologies such as blockchain technology

as integral components that shape the field. By establishing a connection between these innovations and their implications for human resource management, this chapter outlines the potential for groundbreaking advancements. The objectives of this study were meticulously

articulated, linking them to practical applications and strategic goals. Additionally, this chapter identifies critical research gaps by framing the inquiry within broader academic and professional contexts. It highlights the interplay between traditional methodologies and innovative approaches, demonstrating how this synergy can address longstanding inefficiencies and foster organizational success. By synthesizing diverse perspectives, this chapter lays the groundwork for subsequent exploration. It provides readers with the theoretical and practical insights necessary to appreciate the complexity of the subject while inspiring further engagement with the material. Ultimately, this chapter establishes a robust platform for advancing research and contributes to the broader discourse on the integration of cutting-edge technologies into human resource management.

Chapter 2 provides an extensive literature review on the application of blockchain technology in human resource management, focusing specifically on the processes of onboarding and offboarding employees. It evaluates various studies to identify how blockchain technology can enhance efficiency, security, and transparency in HR practices, addressing critical challenges, such as fraud and operational delays. The review underscores the transformative potential of blockchain technology in modernizing HR functions while also revealing significant research gaps that necessitate further exploration. Through a systematic bibliometric analysis of existing literature, this chapter highlights both the current findings and the need for empirical evidence to support theoretical claims. This work aims to encourage the adoption of innovative technological solutions in HRM, paving the way for more secure and effective management of employee lifecycle processes.

Chapter 3 serves as the concluding section of the research, summarizing its key contributions and emphasizing the implications of integrating blockchain technology into human resource management. This study explores the development and application of a blockchain technology-based framework designed to enhance the onboarding and offboarding processes within the automobile manufacturing sector. By addressing issues such as inefficiencies, lack of transparency, and data security vulnerabilities, this study demonstrates how the features of blockchain technology, such as decentralization, immutability, and cryptographic security, can transform HR processes. This chapter reflects on the research methodology, which incorporates bibliometric analysis, primary data collection through interviews, and practical implementation of Ethereum smart contracts. These approaches enabled this study to offer both theoretical insights and practical solutions to the HR challenges. The proposed framework highlights blockchain technology's ability to automate processes, ensure data integrity, and improve

organizational efficiency, particularly in industries where compliance and precision are critical. Despite its significant contributions, this study acknowledges certain limitations, including a geographically limited focus on the Punjab region and the use of purposive sampling, which may affect the generalizability of the findings. This chapter also identifies future research opportunities, such as exploring blockchain technology interoperability, integrating predictive analytics, and testing the framework in diverse industrial contexts. By providing a detailed synthesis of the research outcomes, this chapter reinforces the relevance of blockchain technology in HRM and outlines a path for continued innovation. The findings underscore the transformative potential of blockchain technology in addressing contemporary HR challenges and serve as a valuable resource for practitioners, researchers, and policymakers seeking to modernize HR processes through cutting-edge technology.

Chapter 4 focuses on the critical role of data analysis in bridging raw information with actionable insights, employing advanced tools and methodologies to address inefficiencies in HR onboarding and offboarding processes. This study leveraged Python's robust library ecosystem, including pandas, matplotlib, NLTK, and TextBlob, to process, visualize, and interpret complex datasets with precision. A combination of thematic, content, and sentiment analyses was used to uncover patterns, quantify trends, and gauge stakeholder perceptions. Thematic analysis revealed recurring challenges in traditional HR processes such as inconsistent procedures, delays, and knowledge transfer gaps. Sentiment analysis highlights a predominantly positive outlook on blockchain technology integration, emphasizing its potential to enhance data security, streamline verification, and improve process transparency. However, concerns regarding the implementation costs and resource constraints have also been noted. Content analysis provided a quantitative perspective, identifying recurring issues and aligning them with qualitative insights. This chapter demonstrates how blockchain technology can transform HR operations by addressing inefficiencies, mitigating risks, and ensuring compliance. This study highlights the synergy between advanced data analytics and innovative technologies, underscoring their potential to drive organizational efficiency. The findings provide a comprehensive framework for implementing data-driven solutions in HR, paving the way for improved practices and decision-making strategies.

Chapter 5 explores the innovative integration of blockchain technology into human resource (HR) onboarding and offboarding processes, specifically within the automobile manufacturing industry. It presents a comprehensive framework designed to overcome the limitations of traditional HR systems, which often suffer from inefficiencies, security risks, and compliance

challenges. By harnessing the unique features of blockchain technology, such as its decentralized nature, data immutability, and enhanced transparency, the proposed framework aims to streamline HR operations while ensuring the protection of sensitive employee information. The chapter begins by outlining a conceptual framework that serves as a foundational guide to understanding the key components and relationships involved in the proposed system. This framework illustrates the flow of data throughout the employee lifecycle, facilitating a clear understanding of how information is captured, processed, and utilized. Furthermore, the chapter details a systematic implementation strategy that encompasses the technological, procedural, and organizational aspects necessary for transitioning to a blockchain technology-enabled HR environment. The key benefits of the proposed framework include improved operational efficiency, enhanced data security, and greater compliance with labor regulations. By automating processes through smart contracts and providing real-time visibility to HR activities, organizations can foster a culture of accountability and trust among stakeholders. This chapter emphasizes the importance of aligning the framework with industry standards and stakeholder needs to ensure that the solution is both practical and effective.

Chapter 6 presents the conclusions of the overall research. A detailed conclusion is presented in this chapter. We also present the scope of future work in this chapter.

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Chapter 1: Introduction

Human Resource Management (HRM) is integral to the functioning of organizations across all sectors because it governs the acquisition, development, retention, and offboarding of talent. As businesses become increasingly dynamic and competitive, efficient management of human resources has become a critical factor in achieving organizational success. In recent years, the evolution of technology has significantly transformed HR processes by introducing automation, analytics, and secure digital ecosystems to enhance operational efficiency and decision-making. Among these transformative technologies, blockchain technology is a disruptive innovation that offers unparalleled security, transparency, and traceability for data management. This study explores the application of blockchain technology in the human resource domain, specifically focusing on automating and streamlining onboarding and offboarding processes within the automobile manufacturing industry.

This chapter introduces the foundational concepts of HRM, elaborating on the significance of onboarding and offboarding to ensure smooth employee transitions and alignment with organizational goals. It further explores the role of technology in modern HR practices, emphasizing blockchain technology and its potential to revolutionize traditional frameworks. Through the formulation of research problems, objectives, and methodology, this chapter sets the stage for the proposed blockchain technology-based HR onboarding and offboarding framework. The contributions of this research are outlined, followed by an overview of the thesis structure, to provide a comprehensive understanding of the scope and significance of this study.

This chapter is divided into nine sections: Section 1.1 discusses human resource management. Sections 1.2 and 1.3 discuss HRM onboarding and offboarding processes. Section 1.4 provides the fundamentals of blockchain technology. Section 1.6 provides the problem formulation. Section 1.7 discusses the contributions of the research. Section 1.8 discusses the objectives of the research and finally, section 1.9 provides the overall organization of the thesis.

1.1. Human Resource Management

HRM is a critical function in organizations that focuses on managing the most valuable asset, human capital. It encompasses a range of practices aimed at recruiting, developing, retaining, and effectively utilizing the workforce to achieve organizational goals. HRM serves as the bridge between the organization's strategic objectives and its people, ensuring that employees are motivated, skilled, and aligned with the company's vision (Kroon & Paauwe, 2022). In today's dynamic business landscape, HRM plays a pivotal role in fostering a competitive advantage by nurturing talent and creating an environment that promotes productivity, innovation, and job satisfaction. Traditionally viewed as an administrative function, HRM has evolved into a strategic discipline that directly influences an organization's success (Claes & Lakshman, 2012). It involves a holistic approach to workforce management, integrating areas such as recruitment, training, performance evaluation, employee engagement, and compliance with labor regulations. Moreover, as organizations expand globally and face complex challenges, such as workforce diversity, technological disruptions, and regulatory requirements, the scope and importance of HRM have significantly broadened (Guest, 2001; Stone et al., 2015).

In this era of digital transformation, HRM has increasingly adopted technology to enhance its processes, making it more efficient, transparent, and data-driven. From applicant tracking systems to employee performance analytics, the integration of technology has revolutionized the management of human resources. As organizations strive to keep pace with technological advancements, HRM must embrace innovative solutions to effectively address emerging challenges (Hendry & Pettigrew, 1990). This study focuses on how blockchain technology, a secure and decentralized digital innovation, can be integrated into HRM practices, particularly in onboarding and offboarding processes. By addressing the inefficiencies in these critical areas, this study aims to demonstrate how HRM can evolve to meet the demands of modern business environments.

In the context of the automobile manufacturing industry, the importance of HRM is magnified due to the sector's scale and complexity. For example, according to the International Organization of Motor Vehicle Manufacturers (OICA, 2023), the global automotive industry employs over 14 million people directly in manufacturing roles, with indirect employment exceeding 50 million. In India alone, the automobile sector contributes nearly 7.1% to GDP and employs more than 37

million people, highlighting its critical socio-economic role. Managing such a large and technically skilled workforce demands structured HR practices that balance efficiency, safety, and compliance. Thus, the automobile industry offers an ideal setting to evaluate blockchain-enabled HR frameworks, particularly for onboarding and offboarding, where accuracy and traceability are indispensable.

1.1.1. Introduction to Human Resource Management

HRM can be defined as a strategic approach to the effective and efficient management of people within an organization to help the business gain a competitive advantage. It is primarily focused on aligning the goals and aspirations of employees with the objectives of the organization while ensuring their well-being and professional growth. HRM encompasses a wide range of activities, including talent acquisition, performance management, training and development, employee engagement, and adherence to labor laws and regulations (Stahl et al., 2020). It aims to foster a productive, motivated, and diverse workforce capable of driving the organization toward sustained success. HRM's significance lies in its ability to create and nurture a work environment that promotes collaboration, innovation, and productivity (Dalain, 2023). In the context of the modern business landscape, characterized by globalization, rapid technological advancements, and heightened competition, HRM is pivotal in addressing challenges, such as talent shortages, workforce diversity, and compliance with regulatory requirements. A well-managed human resource function ensures the seamless integration of employees into the organization while equipping them with the skills and knowledge necessary to adapt to evolving roles and responsibilities (Hendry & Pettigrew, 1990; Stone et al., 2015).

The role of HRM is particularly critical in industries such as automobile manufacturing, where precision, efficiency, and safety are paramount. Efficient onboarding ensures that new employees are familiar with the organization's policies, processes, and safety protocols, enabling them to contribute effectively from the outset. Similarly, a structured offboarding process ensures compliance, knowledge transfer, and retention of institutional knowledge, thus minimizing disruptions to the organization (Wood, 1999). The adoption of innovative technologies further amplifies the importance of HRM in achieving organizational success. For instance, blockchain technology offers an unprecedented opportunity to enhance HR processes by introducing transparency, security, and immutability into data management. By leveraging blockchain

technology, HRM can address challenges such as delays, inefficiencies, and inconsistencies in the onboarding and offboarding processes (Anaam et al., 2023). This study focuses on integrating blockchain technology into HRM frameworks to improve the efficiency and effectiveness of these critical processes, demonstrating the transformative potential of technology in human resource practices.

HRM plays a vital role in driving organizational success by ensuring the effective utilization of human capital, which is the most critical resource for any organization (Molina-Azorin et al., 2021). The primary focus of HRM is to attract, develop, and retain talent while fostering a work environment that promotes productivity, innovation, and employee satisfaction. In today's dynamic business environment, HRM has evolved from a support function to a strategic partner, directly influencing an organization's ability to achieve its goals and sustain a competitive advantage. One of the fundamental roles of HRM in organizational success is to align human resource strategies with the overall objectives of the organization. This includes workforce planning, recruitment, and talent acquisition, where HR ensures that the right individuals with the necessary skills and competencies are brought into the organization (Tung, 2016). A robust onboarding process, which is a critical component of this study, equips new employees with the knowledge and tools required to integrate seamlessly into their roles, ensuring their early contributions to organizational performance (Stone et al., 2015).

HRM also ensures continuous employee development through training programs, skill enhancement initiatives, and career progression opportunities. In industries such as automobile manufacturing, where technical expertise and adherence to safety standards are crucial, HRM plays a significant role in maintaining a skilled workforce that is capable of meeting operational demands (J. Zhang & Chen, 2024). By investing in employee growth, HR not only enhances individual performance but also fosters loyalty and reduces turnover, thereby contributing to long-term organizational stability. Performance management is another critical area in which HRM affects organizational success. By establishing clear performance metrics and conducting regular evaluations, HR ensures that employees remain aligned with organizational goals. Feedback mechanisms, rewards, and recognition programs further motivate employees to deliver their best, thereby contributing to overall productivity (Garengo et al., 2022). Additionally, HRM plays a central role in fostering a positive organizational culture, promoting diversity and inclusion, and

maintaining employee well-being, all of which are essential for building a motivated and cohesive workforce (Gill et al., 2025; Wood, 1999).

The HRM's role extends to managing transitions, such as offboarding employees who leave the organization. A structured offboarding process ensures knowledge transfer, compliance, and smooth handling of legal and administrative requirements, thus minimizing disruptions to operations (Zavyalova et al., 2022). This study underscores the importance of integrating blockchain technology into HR processes, including onboarding and offboarding, to address inefficiencies and enhance transparency and security. Moreover, HRM is pivotal in navigating organizational challenges such as technological advancements, market changes, and regulatory compliance. By adopting innovative solutions such as blockchain technology, HRM not only optimizes processes but also prepares the organization to adapt to future demands (Stone et al., 2015). This integration of advanced technologies into HR practices demonstrates how HRM can transform from a traditional administrative function to a driver of innovation and efficiency. HRM serves as the backbone of organizational success by strategically managing the workforce and ensuring the alignment of people, processes, and objectives. Its ability to adapt to changing business environments and incorporate innovative technologies further reinforces its importance in achieving sustainable growth and a competitive advantage (McGovern et al., 1997; Saks, 2022). Through this research, the role of HRM in leveraging blockchain technology to enhance key processes is highlighted as a pathway to redefining the future of human resource practices.

Thus, while HRM broadly supports employee development and organizational performance, its role in structured onboarding and offboarding is particularly crucial for industries with high turnover and compliance demands such as automobile manufacturing.

1.1.2. Core Functions of HRM

HRM encompasses a wide range of functions that are integral to the effective management of human capital within an organization. These core functions form the foundation of HRM practices and directly contribute to the achievement of organizational goals. This research emphasizes the use of blockchain technology in HR processes, and understanding the core functions of HRM provides insight into areas where innovative technologies can bring transformative improvements (Brewster, 2004; Schuler et al., 2002). The core functionality of HRM is illustrated in Figure 1.1.

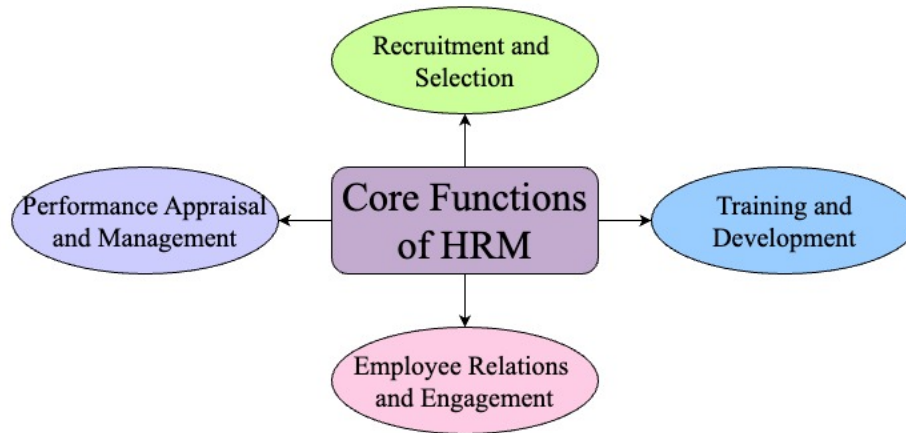


Figure 1.1. Core functions of HRM

Recruitment and Selection: Recruitment and selection are critical processes in HRM that form the foundation of an organization's ability to achieve its objectives. These processes are essential in identifying, attracting, and securing the right talent and ensuring the alignment of employee capabilities with organizational goals. In this research, which focuses on integrating blockchain technology into HR processes for onboarding and offboarding, recruitment and selection play a pivotal role in the initial stages where employee data are gathered and validated. By reimagining these processes through blockchain technology-based systems, the challenges of traditional recruitment methods can be mitigated, thereby enhancing efficiency, transparency, and trust (Boon et al., 2024; Hendry & Pettigrew, 1990).

Recruitment involves identifying an organization's human capital needs and attracting suitable candidates to fulfill these roles. Selection, on the other hand, refers to the process of evaluating and choosing the most qualified candidates from the pool of applicants. Together, these processes ensure that the organization acquires skilled individuals who can contribute to its success. In industries such as automobile manufacturing, effective recruitment, and selection are particularly crucial, as they help secure employees with technical expertise and a strong understanding of industry-specific requirements such as safety regulations and machinery operation (Sulich & Zema, 2020; Wood, 1999).

Training and Development: Training and development are integral components of HRM that focus on enhancing the skills, knowledge, and capabilities of employees to align themselves with organizational goals. These processes are critical for fostering employee growth, improving job

performance, and maintaining a competitive edge in industries such as automobile manufacturing, where technological advancements and operational efficiency are essential. Within the scope of this research, training, and development were examined in the context of a blockchain technology-enabled framework, emphasizing how technology can optimize these functions for greater transparency, efficiency, and effectiveness (Brewster, 2004).

Training refers to the process of equipping employees with the specific skills and knowledge required to effectively perform their current roles. On the other hand, development is a broader concept that involves preparing employees for future roles and responsibilities through career advancement programs, leadership training, and skill-building initiatives. Together, these functions contribute to employee satisfaction, retention, and productivity, which are crucial for organizational success. In the automobile manufacturing industry, training often includes technical skills, such as machinery operation, assembly line processes, and safety protocols, while development focuses on leadership and innovation capabilities (Hendry & Pettigrew, 1986).

Performance Appraisal and Management: Performance appraisal and management are key HRM functions that play a pivotal role in assessing employee contributions, identifying areas for improvement, and aligning individual goals with organizational objectives. In the automobile manufacturing industry, where efficiency, precision, and adherence to strict operational standards are critical, performance appraisals and management ensure that employees meet the required benchmarks for productivity, quality, and safety. This study incorporates performance appraisal and management into a blockchain technology-enabled HRM framework, highlighting how technological advancements can transform these processes to achieve greater transparency, accuracy, and employee satisfaction (Guest, 2011).

Performance appraisal refers to the systematic evaluation of an employee's job performance based on predefined criteria such as productivity, teamwork, skill application, and adherence to organizational standards. Performance management goes beyond appraisal by creating a continuous cycle of goal-setting, feedback, and improvement. Together, these functions help organizations identify top-performing employees, address performance gaps, and make informed decisions regarding promotion, training, and other HR interventions. In the automobile manufacturing industry, performance appraisal is particularly significant because of the high level of specialization required for tasks such as machinery operation, quality control, and safety

compliance. Effective performance management ensures that employees not only meet their job requirements but also contribute to innovation and process optimization within the organization (Brewster, 2004; Wood, 1999).

Employee Relations and Engagement: Employee relations and engagement are central components of HRM that directly influence the success and sustainability of an organization. These aspects encompass the strategies, practices, and systems designed to foster positive interactions between employees and the organization while ensuring that employees remain committed, motivated, and satisfied in their roles. In the automobile manufacturing industry, where operational efficiency and teamwork are paramount, maintaining strong employee relations and high levels of engagement are essential to achieving organizational objectives (Stone et al., 2015; Wood, 1999).

Employee relations involve the management of interactions and relationships between the organization and its workforce, as well as among employees themselves. It includes addressing workplace grievances, ensuring compliance with labor laws, and promoting a harmonious work environment. On the other hand, employee engagement refers to employees' emotional commitment and enthusiasm toward their organization and goals. Engaged employees are more productive, innovative, and likely to contribute positively to organizational success. In industries, such as automobile manufacturing, where tasks often involve high levels of collaboration, precision, and adherence to strict timelines, strong employee relations and engagement contribute to reduced turnover, enhanced productivity, and improved morale. Organizations that prioritize these aspects create a positive workplace culture in which employees feel valued and motivated to perform at their best (Boon et al., 2024; Saks, 2022; Stone & Deadrick, 2015a).

Although all HRM functions contribute to organizational success, onboarding and offboarding represent the most critical points for applying blockchain technology due to their heavy reliance on secure data handling, transparency, and auditability.

1.1.3. Evolution of HRM

The HRM field has undergone significant evolution over time, as depicted in Figure 1.2, transitioning from basic administrative functions to becoming a strategic partner in organizational success. This progression reflects changes in societal needs, technological advancements, and the

recognition of the critical role that people play in achieving business objectives. The historical development of HRM can be traced through various phases, each characterized by distinct approaches, practices, and priorities (Bonache & Festing, 2020). In its earliest form, HRM was primarily focused on administrative tasks, such as payroll processing, record-keeping, and compliance with labor laws. During the Industrial Revolution, as factories expanded and the workforce grew, the need to manage employee wages, attendance, and working conditions became more evident. At this stage, HR was more of a reactive function, ensuring that organizations adhered to basic legal requirements and minimized labor disputes (Guest, 1997).

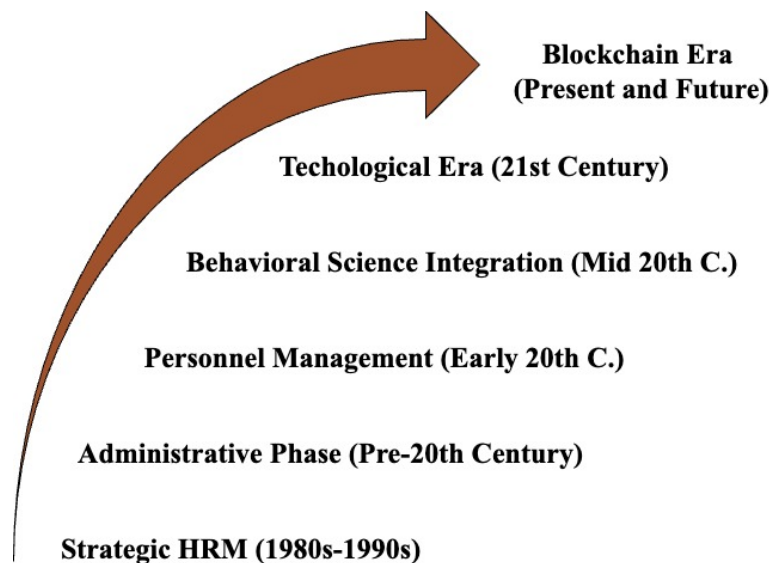


Figure 1.2. Evolution of HRM

In the 1980s and the 1990s, HR evolved into Strategic Human Resource Management (SHRM). This phase emphasizes aligning HR practices with organizational goals to create a competitive advantage. HR departments have become proactive in workforce planning, talent acquisition, and leadership development (Macke & Genari, 2019). Performance management systems were introduced and HR metrics were used to evaluate the impact of people-related initiatives on organizational outcomes. SHRM highlights the role of HR in driving innovation, adaptability, and long-term sustainability. The advent of technology in the 21st century has revolutionized HRM. Automation, data analytics, and cloud-based systems have streamlined traditional HR processes, enabling HR professionals to focus on strategic initiatives. Recruitment platforms, learning management systems, and employee engagement tools enhance efficiency and improve decision-

making. Additionally, the rise of remote work, gig economy models, and flexible work arrangements has further expanded the scope of HRM (Hendry & Pettigrew, 1990; Tung, 2016).

More recently, blockchain technology has emerged as a transformative force in HRM, offering solutions to long-standing challenges, such as data security, transparency, and process efficiency. The decentralized and tamper-proof nature of blockchain technology provides an ideal foundation for managing sensitive HR functions, including onboarding, offboarding, payroll, and performance tracking (Sukalova et al., 2022). In the context of this research, blockchain technology is positioned as a cutting-edge innovation that integrates seamlessly into HRM, addresses existing gaps, and redefines the way organizations manage human capital. Today, HRM places a stronger emphasis on employee-centric practices, recognizing the value of workforce diversity, inclusion, and well-being. Concepts such as emotional intelligence, employee engagement, and work-life balance are now integral to HR strategies (Akdeniz, 2023). Additionally, HR departments are increasingly leveraging artificial intelligence, machine learning, and predictive analytics to enhance talent management, workforce planning, and organizational performance (Stone et al., 2015). The evolution of HRM reflects a dynamic journey shaped by economic, technological, and cultural transformation. From its roots in administrative record-keeping to its current role as a strategic business partner, HRM has continuously adapted to meet the changing needs of organizations and their employees (Freire & Pieta, 2022). This thesis builds upon this legacy by exploring the integration of blockchain technology into HR practices, particularly in onboarding and offboarding processes. By leveraging blockchain technology capabilities, this study seeks to address contemporary HR challenges and contribute to the ongoing evolution of the field (Gill et al., 2025).

1.1.4. Challenges in Modern HRM

In the modern era, HRM faces an array of challenges, as organizations adapt to the demands of an increasingly globalized, digital, and competitive environment (Zamcu, 2014). These challenges are not only operational but also strategic, requiring HR professionals to address issues ranging from workforce diversity to technological integration (Tung, 2016). The major challenges faced by modern HRM systems are shown in Figure 1.3. Understanding and resolving these challenges are crucial for ensuring organizational success and fostering a productive, engaged workforce (Stone & Deadrick, 2015a).

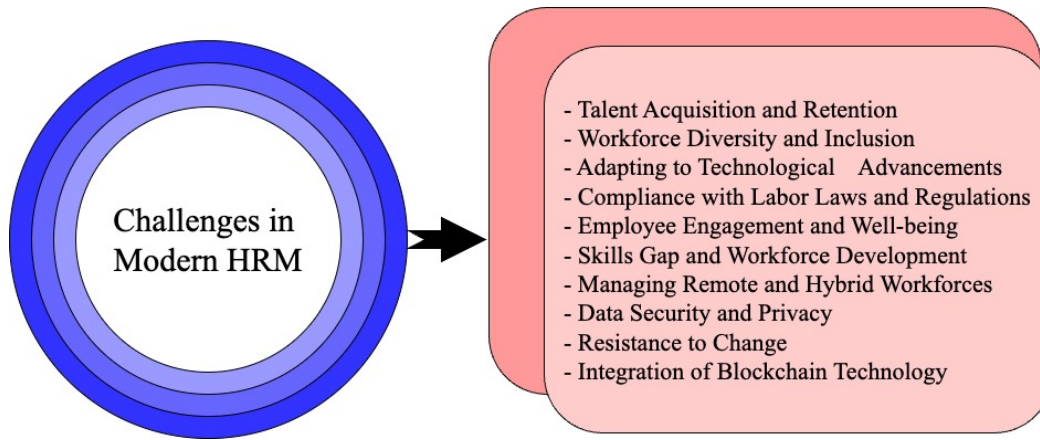


Figure 1.3. Challenges of modern HRM

Modern HRM faces a multitude of challenges in navigating a dynamic workforce landscape, technological innovations, and complex regulations (Abu-Mahfouz et al., 2023). One of the most critical issues is attracting and retaining top talent, as candidates increasingly prioritize meaningful work, professional growth, and value alignment over financial incentives. Additionally, the prevalence of job hopping and the gig economy complicate employee retention, necessitating robust talent management strategies (Ulatowska et al., 2023). Diversity and inclusion have become essential for organizations; however, achieving these goals involves overcoming unconscious biases, fostering equitable workplace cultures, and ensuring equal opportunities for employees from diverse backgrounds (Nurimansjah, 2023). Similarly, adapting to rapid technological advancements requires HR teams to integrate tools such as artificial intelligence and cloud-based systems, while addressing data security concerns and rethinking engagement strategies for remote and hybrid workforces (Boon et al., 2024).

Compliance with labor laws and regulations poses another challenge, as HR departments must stay updated with evolving policies to minimize legal risks (Adams, 2022). At the same time, employee engagement and well-being have gained importance, with organizations emphasizing mental health, work-life balance, and workplace satisfaction (Ershov & Ershova, 2021). Addressing the growing skills gap is critical, as businesses need to invest in upskilling and reskilling programs to align their workforce with emerging demands (Davidescu et al., 2020). The rise of remote and hybrid work models brings about unique difficulties in managing communication, productivity, and inclusion among geographically dispersed teams (Blštáková & Palenčárová, 2021). The increasing reliance on digital HR tools further highlights the need to protect sensitive employee

data from cyber threats while complying with data privacy regulations (Mefi & Asoba, 2020). Resistance to change within organizations remains a significant hurdle in implementing innovative strategies or technologies, requiring HR to prioritize open communication and effective training (Sulich & Zema, 2020).

Blockchain technology has emerged as a transformative tool in HRM, offering improved security, transparency, and efficiency for processes such as onboarding, offboarding, and payrolling (M. Mishra & Joshi, 2020). However, its integration demands a shift from traditional practices and the ability to address resistance through education and stakeholder buy-ins. This study contributes to modern HRM by proposing a blockchain technology-based framework to enhance data security, operational efficiency, and transparency in critical HR processes (Stone & Deadrick, 2015a). By strategically addressing these challenges, HR professionals can foster a resilient and adaptable workforce while aligning with organizational goals and employee needs in a rapidly evolving landscape.

1.1.5. Importance of Innovation in HRM

Innovation in HRM has become a cornerstone of organizational success in today's dynamic business environment (Zhou et al., 2023). As competition intensifies and workforce expectations evolve, HRM must adopt innovative strategies to improve its efficiency, employee satisfaction, and adaptability (Al-Abbadi & Abu Rumman, 2023). These advancements enable organizations to streamline complex HR processes, enhance employee experience, and align workforce management with long-term business objectives (Hendry & Pettigrew, 1986).

Improving operational efficiency is a key outcome of HR innovation with advanced technologies such as artificial intelligence, automation, and blockchain technology transforming recruitment, onboarding, and performance management (Priksht et al., 2023). These tools minimize manual tasks, enhance accuracy, and ensure seamless data management. For instance, blockchain technology introduces security and transparency to processes of HRM, reducing errors, and improving compliance (H. Mishra & Venkatesan, 2021). Employee satisfaction is another critical area that is impacted by innovation. Personalized training programs, flexible work arrangements, and AI-driven feedback mechanisms address modern employees' expectations of growth, inclusion, and well-being (Malik et al., 2023). HRM empowers employees and strengthens their

engagement by designing tailored development plans and fostering an inclusive workplace culture (George* & Thomas, 2019; Islam & Tamzid, 2023).

Innovation also enhances organizational agility, enabling businesses to adapt to market changes and workforce dynamics. Creative workforce planning, including hybrid work structures and gig economy models, enables companies to remain competitive (Than et al., 2023). Blockchain technology-based frameworks, such as those proposed in this study, further support agility by offering decentralized solutions for HR processes. Cultivating a culture of innovation is essential for fostering creativity and collaboration across organizations. HR professionals can create environments that encourage employees to contribute ideas and embrace continuous improvement, aligning their efforts with organizational goals. Additionally, addressing workforce challenges such as talent shortages and skills gaps requires innovative recruitment and upskilling strategies, ensuring that employees stay relevant amidst technological advancements (Brewster, 2004; Lauring & Jonasson, 2024).

Compliance and data security remain priorities in modern HRM, and technologies such as blockchain technology provide secure and immutable records to mitigate risks and maintain regulatory standards. By adopting such innovations, organizations can protect sensitive employee data while streamlining compliance processes. Ultimately, innovation in HRM drives strategic alignment, enabling HR to contribute directly to organizational objectives through predictive analytics, advanced engagement platforms, and performance optimization tools (Choudhary et al., 2023; Lepak et al., 2006). This study underscores the importance of innovation by proposing blockchain technology-based solutions to enhance HR processes, particularly transparency, security, and efficiency. By embracing innovative practices, organizations can strengthen their HR functions, foster continuous growth, and achieve sustainable success in a competitive environment.

1.2. Human Resource Onboarding

Human resource onboarding is a critical talent management process that facilitates the integration of new employees into an organization. It is a structured approach to equipping new hires with the necessary tools, information, and understanding to succeed in their roles (Sani et al., 2023). The onboarding process goes beyond simple administrative formalities and establishes the foundation for employee engagement, productivity, and retention (Godinho et al., 2023). In the automobile

manufacturing industry, effective onboarding is crucial to ensure that employees are well-prepared to adhere to safety standards, operational procedures, and technical requirements (Prathna Kisha & Balu, 2018). As organizations increasingly adopt advanced technologies to improve efficiency, onboarding processes are evolving to include innovative solutions, such as blockchain technology, for the secure and seamless management of employee data (Lalwani, 2023). This section explores the multifaceted aspects of onboarding and its importance, challenges, and relevance to the research at hand, which aims to integrate blockchain technology into HRM systems.

1.2.1. Definition and Purpose of Onboarding

Onboarding, within the HRM domain, is defined as the structured and strategic process of integrating new employees into an organization. This involves providing the tools, resources, and information necessary for new hires to adapt to the company's culture, workflows, and job requirements (Jeske & Olson, 2022). The onboarding process begins before an employee's first day and continues for weeks or months, depending on the organization's goals and the complexity of its role. This comprehensive process ensures that employees are not only operationally ready, but also emotionally engaged and aligned with the organization's vision, mission, and values (Petrilli et al., 2022). The primary purpose of onboarding is to bridge the gap between recruitment and active employment, thereby enabling a smooth transition for new employees. It aims to enhance employee productivity by equipping employees with a clear understanding of their roles and responsibilities (Paulus, 2023). Onboarding also serves as a platform for familiarizing employees with organizational policies, safety protocols, and compliance requirements, which are especially significant in industries such as automobile manufacturing, where safety and precision are critical (Carucci, 2018; Peacock & Ruppel, 2019; Snell, 2006).

In addition to operational readiness, onboarding plays a crucial role in fostering employee engagement and retention. Research indicates that a well-structured onboarding program can significantly reduce turnover rates by ensuring that new hires feel welcome and valued (Palmquist, 2023). Furthermore, onboarding helps build strong relationships between employees and their managers, colleagues, and organization. This relationship-building fosters a sense of belonging and commitment, contributing to long-term organizational success (Carpenter & de Charon, 2014; Shufitinsky & Cox, 2019). In the context of the proposed research, onboarding has been reimagined through the integration of blockchain technology to enhance the efficiency,

transparency, and security of data management. By automating data-handling processes and ensuring immutability, the blockchain technology-based onboarding framework addresses common challenges, such as administrative delays, data inconsistencies, and compliance risks. This innovative approach aligns with the research objectives of leveraging technology to improve HRM practices, making onboarding not only a foundational step for employee integration but also a technologically advanced process for organizational growth (Abu Ziden & Chin Joo, 2020).

1.2.2. Importance of Onboarding in Organizational Success

Onboarding is a critical process that significantly influences organizational success by laying the groundwork for employee engagement, productivity, and retention. It is not merely an administrative procedure, but a strategic function that aligns new hires with the organization's objectives, culture, and values (Gomes Rickardo & Sousa Daniele, 2023). For organizations, particularly in complex industries such as automobile manufacturing, effective onboarding is essential to ensure that employees are fully prepared to meaningfully contribute to operational efficiency and organizational growth. One of the primary reasons that onboarding is vital for organizational success is its effect on employee retention (Walker-Schmidt et al., 2022). A structured onboarding process creates a positive first impression, fostering a sense of belonging and confidence in new hires. This reduces the likelihood of early turnover, which is both costly and disruptive to the operations. By addressing common challenges, such as role clarity and cultural alignment during onboarding, organizations can build stronger relationships with their workforce, ensuring long-term loyalty and commitment (Caldwell & Peters, 2018; Maksymiuk, 2017; Maurer, 2018; Shufiitinsky & Cox, 2019).

Onboarding also plays a pivotal role in enhancing employees' productivity. When employees are provided with clear guidance, appropriate training, and access to necessary resources, they can begin to contribute more effectively and efficiently to their roles (M & R, 2017). This is particularly important in industries that demand technical expertise and precision such as automobile manufacturing. A comprehensive onboarding program helps employees quickly adapt to their roles, minimize errors and downtime, and ensure seamless integration into the production process. Moreover, onboarding directly influences employee engagement, which is a critical factor in achieving organizational success (Esha et al., 2023). Engaged employees are more likely to be motivated, innovative, and collaborative, which positively impacts their overall performance.

Organizations can build a foundation of trust and commitment by fostering a supportive environment during onboarding. This not only improves individual performance but also strengthens team dynamics, which are essential for achieving shared goals (Byford et al., 2017; Carucci, 2018; Ross et al., 2014). In the context of this study, the importance of onboarding was further amplified by the integration of blockchain technology. Traditional onboarding processes often face challenges such as delays, inefficiencies, and data management issues. By leveraging the blockchain technology's decentralized and secure nature, organizations can enhance the onboarding process through automated document verification, secure data sharing, and immutable record-keeping. This innovation not only addresses operational challenges but also reinforces the organization's commitment to technological advancement and employee satisfaction (Abu Ziden & Chin Joo, 2020).

1.2.3. Phases of Onboarding

Onboarding is a structured, multiphase process designed to effectively integrate new employees into an organization (Krugielka et al., 2023). Each phase serves a distinct purpose and collectively ensures that new hires feel welcomed, informed, and prepared to contribute to the organization's success (Bentum, 2023). In the context of the automobile manufacturing industry, where operational precision and technical expertise are paramount, a well-designed onboarding process ensures that employees are aligned with the organization's goals and equipped with the skills and knowledge needed for their roles (Maksymiuk, 2017). The HRM onboarding phases are illustrated in Figure 1.4.

Pre-Onboarding Phase: The onboarding journey begins even before the employee's first day at work. This phase focuses on preparing a new hire and organization for a smooth transition. Activities in this phase included sending offer letters, sharing welcome emails, and providing access to essential pre-employment forms or documents. For industries such as automobile manufacturing, this phase may also involve sending details about safety protocols, preliminary training schedules, and company policies to ensure that new employees are familiar with the working environment from the outset. This phase helps reduce anxiety, establish clear expectations, and set the tone for a productive employment relationship (Caldwell & Peters, 2018; Maksymiuk, 2017).

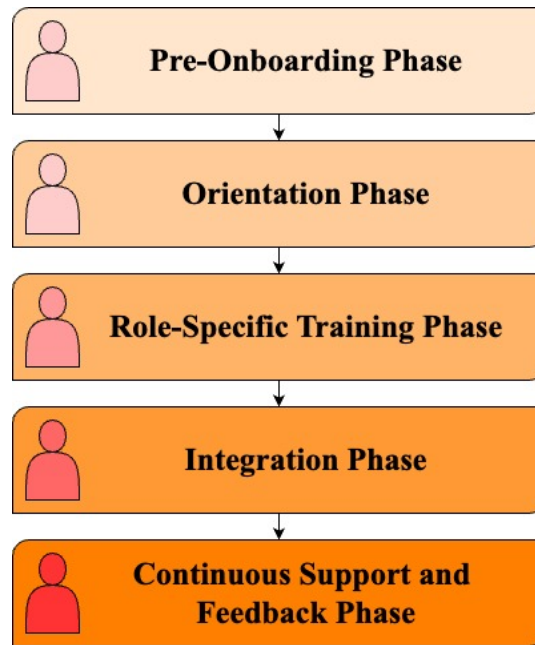


Figure 1.4. Phases of HRM onboarding process

Orientation Phase: The orientation phase typically occurs on the employee's first day or week. It aims to introduce new hires into the organizational culture, structure, and resources. This phase included formal presentations, workplace tours, and sessions that outlined the company's history, mission, and values. Employees are also introduced to key team members and mentors, who can guide them through the initial stages of their roles. In the automobile manufacturing context, this phase might include an overview of production processes, quality assurance protocols, and safety measures, ensuring that employees understand the broader organizational framework within which they operate (Maksymiuk, 2017; Maurer, 2018).

Role-Specific Training Phase: This phase focuses on equipping employees with the skills and knowledge required for their roles. Training sessions may include technical skill development, hands-on demonstrations, and role-specific workshops. For example, in an automobile manufacturing setting, this could involve training in assembly-line operations, machinery handling, and adherence to safety standards. Blockchain technology can enhance this phase by providing secure access to training materials, tracking progress, and verifying certifications through decentralized records (Carucci, 2018; Maksymiuk, 2017).

Integration Phase: The integration phase emphasizes aligning employees with their teams and workflows. This includes assigning specific projects, setting performance expectations, and

providing opportunities for collaborative engagement. This phase ensures that employees not only understand their responsibilities but also build relationships with colleagues and supervisors. In the context of this research, blockchain technology can streamline this phase by facilitating secure data sharing and transparent communication channels, ensuring seamless collaboration across teams (Carucci, 2018).

Continuous Support and Feedback Phase: The onboarding process does not end with initial integration; it extends into the first few months of employment. During this phase, continuous support and feedback are provided to help employees address challenges and adapt fully to their roles. Regular check-ins, mentoring sessions, and performance reviews were integral to this phase. Blockchain technology can play a role by maintaining a transparent record of feedback and performance metrics, enabling data-driven support and growth opportunities for employees (Maksymiuk, 2017; Stein & Christiansen, 2010).

The onboarding process consists of several interconnected phases that guide new employees, from their initial introduction to becoming fully integrated and productive members of the organization. Each phase plays a critical role in ensuring that employees are not only prepared for their roles but also aligned with the organization's values and objectives. By integrating blockchain technology into the onboarding process, this study highlights the potential for creating a more efficient, transparent, and secure framework that addresses modern HR challenges while fostering employee success (Cable et al., 2013; Maksymiuk, 2017; Ross et al., 2014; Stein & Christiansen, 2010).

1.2.4. Key Components of Onboarding in HRM

The onboarding process in HRM encompasses a series of strategic components designed to effectively integrate new employees into an organization. These components ensure that new hires are not only equipped with the necessary tools and knowledge to perform their roles, but also feel connected to the organization's culture, values, and objectives. The key components of onboarding in HRM are particularly significant in the automobile manufacturing industry, where operational efficiency and employee readiness are crucial for success (Cable et al., 2013).

Pre-Employment Preparation: This component involves preparing both the new hire and the organization before the first day of employment. This includes issuing offer letters, collecting pre-employment documentation, and providing access to digital onboarding portals. Pre-employment

preparation ensures a seamless transition into the organization and reduces administrative bottlenecks on the first day. In the automobile manufacturing industry, this may also involve sending safety guidelines or videos related to factory protocols (Cable et al., 2013; Stein & Christiansen, 2010).

Introduction to Organizational Culture: A critical component of onboarding is the introduction of new hires to the organization's culture, values, and mission. This helps employees understand the company's identity and role. Activities such as interactive sessions with leadership, workshops on corporate values, and company history presentations foster alignment with organizational goals. In industries such as automobile manufacturing, where teamwork and adherence to safety and quality standards are essential, cultural alignment ensures a unified approach to achieving organizational objectives (Cable et al., 2013; Stein & Christiansen, 2010).

Compliance and Policy Adherence: Ensuring that new employees are familiar with company policies and comply with legal and regulatory requirements is a vital part of onboarding. This component includes providing employees with an employee handbook, outlining workplace rules, and securing signed acknowledgments for safety and confidentiality agreements. Blockchain technology can be utilized to securely store and verify compliance documents, ensuring a tamper-proof record for both the organization and employees (Byford et al., 2017; Cable et al., 2013).

Role-Specific Orientation and Training: Role-specific orientation focuses on preparing employees for the responsibilities of their positions. This included detailed training sessions, access to job-specific resources, and skill-building workshops. In the automobile manufacturing industry, this component may involve technical training in machinery operations, assembly processes, and quality assurance protocols. Blockchain technology can enhance this process by maintaining a verifiable record of the completed training sessions and certifications (Cable et al., 2013; Carucci, 2018).

Resource Allocation and System Access: Providing new hires with the resources and tools they need to succeed in their roles is an essential component of onboarding. This includes assigning equipment, granting system access, and creating e-mails. In the context of this study, blockchain technology can be leveraged to securely and efficiently manage access credentials, ensuring that employees can seamlessly access the tools and systems required for their roles (Cable et al., 2013; Maurer, 2018).

Mentorship and Social Integration: Onboarding is not just about imparting knowledge; it also involves fostering relationships and building a sense of community within the organization. Assigning mentors, organizing team introductions, and scheduling social activities helps new hires integrate into their teams. In automobile manufacturing, mentorship programs can connect employees with experienced professionals who can guide them through technical and operational challenges (Cable et al., 2013; Caldwell & Peters, 2018).

Continuous Feedback and Check-ins: The onboarding process extends beyond the initial weeks of employment. Regular check-ins and feedback sessions allow HR professionals and managers to monitor the progress of new hires and address concerns or challenges. This continuous feedback loop ensures that employees feel supported and valued, which can increase their engagement and retention. Blockchain technology can play a role in securely recording feedback and tracking progress metrics in a transparent and tamper-proof manner (Cable et al., 2013; Shufitinsky & Cox, 2019).

Evaluation and Improvement: Finally, onboarding involves evaluating the effectiveness of the process itself. Organizations should collect feedback from new employees regarding their onboarding experience and use this information to refine the process for future hires. For industries such as automobile manufacturing, where precision and efficiency are crucial, this iterative approach ensures that the onboarding process remains robust and adaptive to organizational needs (Cable et al., 2013).

The onboarding process in HRM is a multifaceted approach that combines administrative, cultural, and developmental components to ensure the successful integration of new employees. By incorporating modern technologies, such as blockchain technology, the onboarding framework can become more efficient, transparent, and secure, addressing both organizational and employee needs while aligning with the objectives of this research.

1.2.5. Challenges in Onboarding Processes

The onboarding process, while integral to integrating new employees into an organization, often faces several challenges that hinder its effectiveness. These challenges can arise from inconsistencies in implementation, a lack of resource alignment, or inadequate use of technology, ultimately affecting employee engagement, productivity, and retention. One of the primary

challenges in onboarding is fragmented communication. New hires frequently experience confusion due to unclear expectations and insufficient communication regarding their roles, responsibilities, and organizational culture. This issue is exacerbated when multiple departments such as human resources, IT, and team managers fail to collaborate seamlessly, resulting in delays in access provisioning and training schedules (Labrosse, 2008; Ross et al., 2014; Stein & Christiansen, 2010).

Another significant challenge is the manual and time-intensive processes. Many organizations still rely on paper-based or semi-digital onboarding systems, which can lead to inefficiencies, errors in document handling, and a lack of process scalability. These manual tasks not only delay the onboarding timeline but also divert HR resources from more strategic activities such as employee engagement and culture-building. In addition, the lack of personalization in onboarding programs poses a critical issue. A standardized, one-size-fits-all approach often fails to address employees' specific needs based on their roles, departments, or prior experience. This lack of customization can lead to disengagement and slower acclimation to the new work environment. Another recurring challenge is inadequate training and resource allocation. Organizations may neglect to provide timely training or access to necessary tools and resources, which leaves new employees ill-equipped to effectively perform their tasks. This often stems from insufficient coordination between HR and operational units as well as limited budget allocation for onboarding programs (Abu Ziden & Chin Joo, 2020; Becker & Bish, 2021; Maurer, 2018).

Compliance-related complexities create additional obstacles. Industries with stringent regulatory requirements, such as healthcare or finance, often face difficulties in ensuring that all legal and organizational compliance measures are met during onboarding (Moon, 2018). Missing or incomplete documentation, delayed background checks, and improper certification verification can pose risks to an organization's credibility and operations. Finally, the absence of feedback mechanisms is a major limitation of the onboarding process. Without a structured way to collect and analyze feedback from new employees, organizations miss critical insights that could improve their onboarding experience (Capitano et al., 2024). This oversight may contribute to high turnover rates among recently onboarded employees as unresolved pain points accumulate over time. Addressing these challenges requires organizations to adopt innovative onboarding solutions such as centralized digital platforms, automation tools, and role-specific frameworks. By overcoming

these obstacles, organizations can create seamless, efficient, and engaging onboarding experiences that foster long-term employee satisfaction and loyalty (Becker & Bish, 2021; Carucci, 2018).

1.3. Human Resource Offboarding

Human resource offboarding, the structured process of transitioning an employee out of an organization, holds significant importance in maintaining operational continuity and safeguarding organizational knowledge. In the automobile industry, where workforce dynamics and knowledge retention are critical, an effective offboarding process ensures that departing employees leave professionalism, while protecting the organization's interests (Sturt, 2019). Beyond administrative formalities, such as clearance processes and final settlements, offboarding encompasses critical activities, such as knowledge transfer, exit interviews, and ensuring compliance with legal and contractual obligations. This phase not only impacts the departing employee's perception of the organization but also influences the morale and productivity of the remaining staff. In this context, integrating innovative technologies such as blockchain technology into offboarding workflows can address existing inefficiencies and foster transparency, trust, and accountability (Bansal, 2023). By examining offboarding challenges and exploring the role of advanced technologies, this section highlights how a robust framework for offboarding can drive operational excellence and reinforce an organization's commitment to ethical and structured HR practices (Dachner & Makarius, 2021; Klotz et al., 2021; Lee & Varon, 2020).

1.3.1. Definition and Purpose of Offboarding

Offboarding refers to the systematic process undertaken by an organization to manage an employee's exit from the workforce, whether voluntary or involuntary. It encompasses various administrative, legal, and interpersonal activities designed to ensure a seamless transition for both the departing employee and the organization (Norton, 2014). In the automobile industry, where workforce expertise and intellectual property play a pivotal role, a structured offboarding process mitigates the risks related to knowledge loss, compliance issues, and operational disruptions. The primary purpose of offboarding is to foster a smooth and professional departure, maintaining positive relationships while safeguarding the organization's assets and reputation (Sturt, 2019). This process typically involves exit interviews, the return of company property, final payroll settlements, knowledge transfer initiatives, and deactivation of access to organizational systems.

Additionally, offboarding ensures compliance with labor laws, confidentiality agreements, and industry regulations, which are critical in sectors such as the automobile industry, where proprietary designs and strategies are highly sensitive (Lee & Varon, 2020).

A well-defined offboarding process is not merely administrative but also serves strategic objectives. It provides an opportunity to gain insights from departing employees through feedback, allowing organizations to identify potential areas for improvement in their workplace practices (Sturt, 2019). Furthermore, by handling offboarding professionally and transparently, organizations can reinforce their employer brand, ensuring that departing employees become advocates rather than detractors. This is particularly crucial in industries with highly competitive talent markets because former employees often influence prospective hires and business partnerships. The offboarding processes can be significantly enhanced with the advent of blockchain technology. Blockchain technology features, such as immutable record-keeping, decentralized access control, and automated workflows via smart contracts, can streamline key offboarding tasks and ensure data accuracy, accountability, and transparency. The integration of blockchain technology in offboarding has the potential to address long-standing challenges, such as managing exit formalities efficiently and safeguarding sensitive organizational information, thereby creating a secure and scalable framework for employee transitions (Dachner & Makarius, 2021; Gajendran & Somaya, 2016).

1.3.2. Importance of Offboarding in Organizational Success

Offboarding is a critical component of HRM that significantly affects an organization's long-term success. While much emphasis is often placed on onboarding processes, the offboarding phase plays an equally pivotal role in maintaining operational continuity, preserving organizational knowledge, and enhancing employer branding. In the automobile industry, where intellectual property and skilled labor are vital, a structured offboarding process ensures minimal disruption and reinforces the organization's integrity (Norton, 2014). A well-executed offboarding process helps safeguard an organization against potential risks, including data breaches, intellectual property theft, and compliance violations. Departing employees often have access to sensitive information such as proprietary designs, supply chain details, or manufacturing processes. Ensuring a secure transition by deactivating access rights and retrieving company assets is crucial.

Moreover, clear communication regarding legal obligations, such as non-disclosure agreements, helps mitigate future disputes or misuse of proprietary data (Gajendran & Somaya, 2016).

Offboarding also serves as an opportunity for knowledge transfer, ensuring that departing employees' expertise is effectively transitioned to other team members. This is particularly important in the automobile sector, where employees' expertise often aligns with specialized roles. Structured exit interviews and documentation of key responsibilities can help organizations retain institutional knowledge and identify areas for process improvement. From a cultural perspective, offboarding reflects an organization's values and commitment to maintaining respectful relationships with employees. A positive offboarding experience not only enhances the departing employee's perception of the company but also influences external opinions, including potential talent and business partners. Employees who leave on good terms are more likely to advocate for the organization, contributing to a strong employer brand in the competitive automobile industry (Sirois, 2021).

Blockchain technology can further enhance the importance of offboarding by offering secure automated solutions for managing this critical process. Features such as immutable records, decentralized data management, and smart contracts streamline tasks such as severance payments, compliance tracking, and feedback collection. These advancements not only reduce administrative burdens but also ensure accountability and transparency, reinforcing trust between employers and employees. Offboarding is not merely an administrative task but also a strategic tool that contributes to organizational stability, reputation, and growth. For industries such as automobile manufacturing, adopting robust offboarding practices, possibly augmented by innovative technologies such as blockchain technology, can significantly enhance both operational efficiency and long-term success (Nayak & Park, 2020).

1.3.3. Phases of Offboarding

Offboarding, a crucial aspect of human resource management, comprises several distinct phases, as shown in Figure 1.5 essential for the seamless transition of departing employees. These phases ensure that organizational processes remain efficient and that departing employees experience a dignified exit. In the context of blockchain technology implementation in HR, these phases can be enhanced through transparent and secure digital records, thereby ensuring compliance and data integrity throughout the offboarding journey.

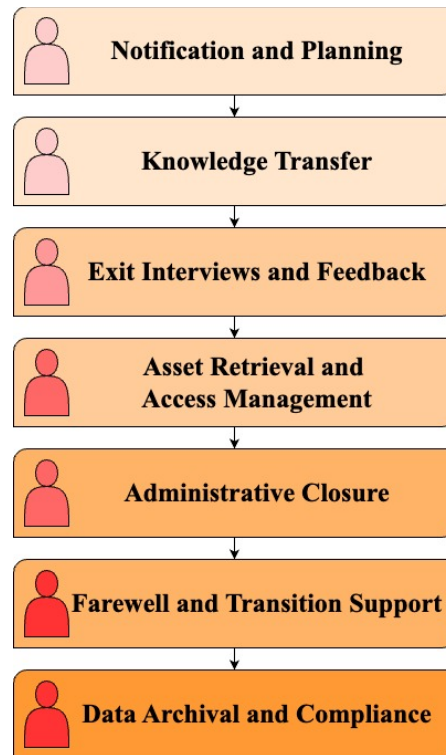


Figure 1.5. Phases of HRM offboarding process

Notification and Planning: The offboarding process initiates notifications to relevant stakeholders, including HR, managers, and IT departments. Planning involves outlining tasks, such as knowledge transfer, equipment retrieval, and exit interviews, ensuring a structured approach to employee departure (Lee & Varon, 2020; Nayak & Park, 2020).

Knowledge Transfer: Effective knowledge transfer is critical for preserving organizational knowledge. Blockchain technology can facilitate secure documentation and transfer of critical information, ensuring continuity in operations and minimizing knowledge gaps (Lee & Varon, 2020; Nayak & Park, 2020).

Exit Interviews and Feedback: Exit interviews provide valuable insights into employees' experiences and reasons for departure. Blockchain technology can enhance the confidentiality and transparency of feedback collection, fostering an environment in which departing employees feel comfortable sharing can provide insights (Lee & Varon, 2020; Nayak & Park, 2020).

Asset Retrieval and Access Management: Managing the retrieval of company assets, including physical equipment and digital access rights, is pivotal for maintaining security and compliance.

A blockchain technology's immutable ledger can track asset return processes, reduce administrative errors, and enhance accountability (Lee & Varon, 2020; Nayak & Park, 2020).

Administrative Closure: Administrative closure involves finalizing paperwork, including benefits processing, payroll adjustments, and legal documentation. Blockchain technology's smart contract capabilities can automate and streamline these processes, ensuring accuracy and reducing the processing time (Lee & Varon, 2020; Nayak & Park, 2020).

Farewell and Transition Support: Offering emotional support and acknowledging departing employees' contributions is essential for maintaining positive employer branding and employee relations. Blockchain technology can facilitate secure communication channels for ongoing support and future engagement (Lee & Varon, 2020; Nayak & Park, 2020).

Data Archival and Compliance: Archiving employee records and ensuring compliance with data protection regulations are critical post-offboarding tasks. The blockchain technology's decentralized storage and cryptographic security features provide tamper-proof data archival solutions, safeguarding sensitive information against unauthorized access (Lee & Varon, 2020; Nayak & Park, 2020).

The incorporation of blockchain technology into the offboarding process enhances transparency, security, and efficiency. By leveraging blockchain technology capabilities, organizations can streamline offboarding procedures, mitigate risks, and uphold ethical standards, thereby fostering a conducive work environment and reinforcing employer-employee trust.

1.3.4. Key Components of Offboarding in HRM

Effective offboarding in HRM encompasses several key components essential for managing the departure of employees, while maintaining organizational integrity and employee relations. Each component plays a crucial role in ensuring smooth transition and preserving the organization's reputation and operational continuity.

Policy and Procedure Development: Establishing clear offboarding policies and procedures is fundamental to effective HRM. These guidelines outline the steps, responsibilities, and timelines for offboarding processes to ensure consistency and compliance with legal and ethical standards (Nayak & Park, 2020; Sirois, 2021).

Communication and Notification: Transparent communication is vital during the offboarding process. HR ensures timely notifications to relevant stakeholders, including departments affected by employee departure, to facilitate smooth handovers and minimize operational disruptions (Lee & Varon, 2020; Nayak & Park, 2020).

Exit Planning and Preparation: Preparation is key to a structured offboarding experience. HR collaborates with managers to plan for knowledge transfer, workload redistribution, and succession planning, ensuring a minimal impact on team productivity and morale (Lee & Varon, 2020; Nayak & Park, 2020).

Compliance and Legal Obligations: Adhering to legal and regulatory requirements during offboarding is paramount. HR ensures compliance with labor laws, data protection regulations, and company policies, safeguarding employee rights and organizational integrity (Lee & Varon, 2020; Nayak & Park, 2020).

Knowledge Transfer and Documentation: Preserving institutional knowledge is critical to business continuity. HR facilitates the transfer of job-related information and documentation to successors or team members by leveraging digital tools for secure and efficient knowledge management (Lee & Varon, 2020; Nayak & Park, 2020).

Exit Interviews and Feedback Collection: Exit interviews provide valuable insights into employees' experiences and reasons for departure. HR confidentially conducted these interviews to gather feedback on organizational strengths and areas for improvement, informing future HR strategies (Lee & Varon, 2020; Nayak & Park, 2020).

Benefits and Payroll Administration: Managing benefits continuation, final pay calculations, and pension arrangements requires meticulous attention to detail. HR ensures the accurate processing of financial entitlements, reflecting employees' tenures and contributions to the organization (Lee & Varon, 2020; Nayak & Park, 2020).

IT and Security Offboarding: Securing digital assets and revoking access rights are critical to data protection and cybersecurity. HR collaborates with IT departments to deactivate accounts, retrieve company devices, and mitigate risks associated with unauthorized data access (Lee & Varon, 2020; Nayak & Park, 2020).

Employee Well-being and Transition Support: Supporting employees' emotional well-being and career transitions fosters positive employer branding. HR provides resources for career counseling, networking opportunities, and job referrals, reinforcing an organization's commitment to employee welfare (Lee & Varon, 2020; Nayak & Park, 2020).

Effective offboarding in human resource management (HRM) encompasses comprehensive planning, communication, compliance, and employee support. By prioritizing these key components and leveraging technological advancements such as blockchain technology for secure data management, organizations can uphold ethical standards, mitigate risks, and maintain positive employer-employee relationships throughout the offboarding process.

1.3.5. Challenges in Offboarding Processes

Despite their importance, offboarding processes in HRM face several challenges that can complicate the departure of employees and impact organizational efficiency and reputation. Addressing these challenges is crucial for ensuring a seamless transition and maintaining positive employer-employee relationships. Managing sensitive employee data during offboarding raises concerns regarding data security and privacy. Ensuring compliance with data protection regulations, while securely archiving and transferring digital records, poses challenges, particularly in maintaining confidentiality and preventing unauthorized access. Effective communication between HR managers, IT departments, and departing employees is essential for smooth offboarding. However, communication gaps or delays in notifying stakeholders can lead to misunderstandings, logistical errors, and delays in completing the offboarding tasks (Sirois, 2021).

Navigating legal requirements and compliance obligations during offboarding may be complex. HR must adhere to labor laws, contractual obligations, and industry regulations governing employee rights, severance packages, and data management to ensure fairness and legal protection for both parties. Offboarding can evoke mixed emotions among departing employees and their colleagues. Managing emotional impact, including feelings of uncertainty or resentment, requires empathy and effective communication to uphold morale and organizational culture during transitions. Preserving institutional knowledge and ensuring seamless succession planning is critical during offboarding. Transferring job responsibilities, skills, and relationships to successors

or team members requires strategic planning and training to mitigate knowledge gaps and maintain operational continuity (Dachner & Makarius, 2021; Dosanjb, 1995; Klotz et al., 2021).

Integrating digital tools and automation into offboarding processes can streamline administrative tasks and enhance their efficiency. However, technological integration challenges, such as system compatibility issues or resistance to digital transformation, may hinder the effectiveness of adoption and implementation. Offboarding experience influences an organization's employer brand and reputation. Mishandling offboarding processes, such as insensitive communication or inadequate support for departing employees, can damage trust, diminish employee loyalty, and deter potential talent. Addressing the challenges in offboarding processes requires proactive planning, effective communication, and adherence to legal and ethical standards. By prioritizing data security, enhancing stakeholder coordination, supporting employee well-being, and leveraging technology for efficiency, HR can mitigate risks and foster a positive offboarding experience that upholds organizational integrity and enhances employer-employee relationships (Blatz, 2013; Klotz et al., 2021).

1.4. Fundamentals of Blockchain Technology

Blockchain technology, initially recognized as the underlying innovation behind cryptocurrencies, such as Bitcoin, has rapidly evolved into a transformative force across diverse sectors, including HRM. Blockchain technology is a decentralized and distributed ledger system that enables secure and transparent transactions without the need for intermediaries. The profound impact of this technology lies in its ability to establish trust, ensure data integrity through cryptographic security, and facilitate automated processes through smart contracts. In the context of HRM, blockchain technology offers promising applications to streamline operations, enhance transparency in employee transactions, and revolutionize processes such as offboarding (C. Zhang et al., 2020). This section explores the fundamental concepts, features, applications, challenges, and future prospects of blockchain technology in HRM, emphasizing its role in optimizing offboarding processes and fostering efficiency and compliance in organizational practices.

1.4.1. Introduction to Blockchain Technology

Blockchain technology functions as a distributed ledger comprising interconnected blocks of records, each secured through cryptographic hashes. These blocks contain data such as transaction

information, timestamps, and cryptographic hashes of the preceding blocks. This structural integrity forms an immutable chain of blocks akin to a linked list in the data structures, where each subsequent block reinforces the security of the entire chain. Altering any block retroactively requires modifying all subsequent blocks and gaining network consensus, thus fortifying the blockchain technology's resistance to tampering and ensuring transaction integrity (Abou Jaoude & George Saade, 2019; Iansiti & Lakhani, 2017). This attribute safeguards against fraudulent activities, such as asset creation, double spending, counterfeiting, and theft. The work on blockchain technology is shown in Figure 1.6. Blockchain technology networks operate on a peer-to-peer (P2P) basis, where nodes collaborate by using consensus algorithms to validate and append new blocks. Despite the potential for blockchain technology forks to temporarily alter records, blockchain technology systems are designed with inherent security features and exhibit robust fault tolerance against Byzantine failures (Soze, 2017; Tasatanattakool, 2018). Initially introduced in 2008 by Satoshi Nakamoto as the foundational technology for Bitcoin, blockchain technology revolutionized digital currency transactions by resolving the double-spending problem without relying on centralized authorities or servers. This innovation has inspired subsequent blockchain technology applications and cryptocurrencies, establishing blockchain technology as a pivotal technology in digital finance (Haber & Scott Stornetta, 1991; Tasatanattakool, 2018).

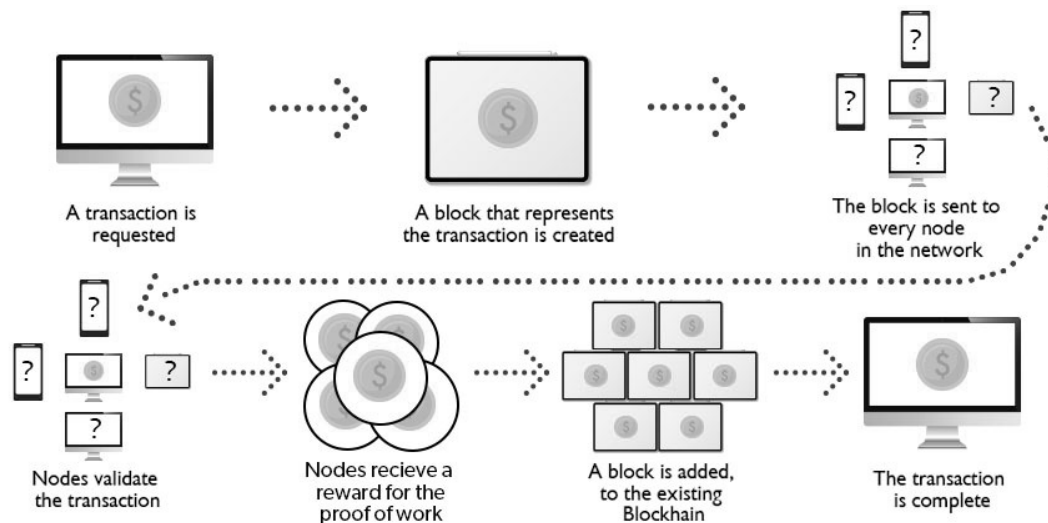


Figure 1.6. Working of blockchain technology

Public blockchain technology is accessible and transparent and is widely adopted across cryptocurrencies and other decentralized applications. These blockchain technologies serve as

distributed ledgers that are accessible to all network participants, exemplifying a secure and decentralized computing paradigm. By contrast, private blockchain technology caters to business applications, offering controlled access and enhanced security models tailored to organizational needs. Critics caution against privatized blockchain technology lacking robust security frameworks, labeling them unreliable; however, proponents argue that well-designed permissioned blockchain technology may offer superior decentralization and operational security compared to their permissionless counterparts (Carter & Ubacht, 2018; Zhang et al., 2020; Zheng et al., 2017).

Blockchain technology signifies a transformative leap in secure digital transactions, underpinned by decentralized consensus and cryptographic principles. Its application extends beyond cryptocurrencies to encompass diverse sectors, such as finance, supply chain management, healthcare, and human resource management. By ensuring data integrity, enhancing transparency, and mitigating the trust issues inherent in centralized systems, blockchain technology continues to shape the future of digital innovation and promises enhanced efficiency and reliability across global industries (Di Francesco Maesa & Mori, 2020; Soze, 2017).

1.4.2. Key Concepts of Blockchain Technology

Blockchain technology, which is integral to this research, revolves around several core concepts that underpin its functionality and appeal across various industries, including human resource management. Understanding these key concepts is essential for understanding how blockchain technology can revolutionize HR processes, particularly onboarding and offboarding within the automobile manufacturing sector (Hegadekatti, 2018; X. Wang et al., 2017). The major features of blockchain technology utilized for onboarding and offboarding are shown in Figure 1.7.

Decentralization: Decentralization is a fundamental principle of blockchain technology that distinguishes it from traditional centralized databases. In a decentralized network, data are not stored in a single location but controlled by a central authority. Instead, they are distributed across multiple nodes (computers) that participate in the network. Each node maintains a copy of the entire blockchain technology, ensuring redundancy and resilience to single points of failure. This distributed architecture enhances data integrity and availability because changes to the blockchain technology must be validated and agreed upon by a consensus mechanism among the nodes (Mahapatra, 2020; C. Zhang et al., 2020).

Immutability: Immutability refers to the property of blockchain technology data that is tamper-proof and irreversible once recorded. Once a transaction or data entry is added to the blockchain technology, it becomes a part of a sequentially linked chain of blocks. Each block contains a cryptographic hash of the previous block, creating a permanent record that cannot be altered retroactively without altering all the subsequent blocks. This cryptographic chaining ensures that any attempt to tamper with data is immediately detected by network consensus, thereby preserving the integrity and trustworthiness of the information stored in the blockchain technology (Dai et al., 2019; Sharif & Ghodoosi, 2022).

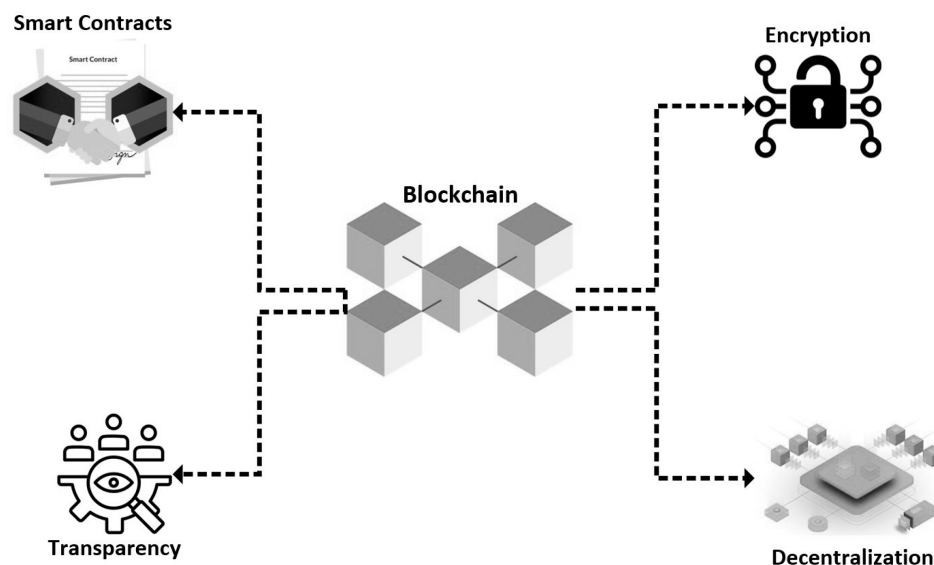


Figure 1.7. Feature of blockchain technology

Cryptographic Security: Cryptographic security forms the backbone of blockchain technology's robust protection mechanisms. It involves the use of advanced cryptographic techniques such as hashing algorithms, digital signatures, and public-key cryptography to secure transactions and data within the blockchain technology network. Hashing algorithms convert data into a fixed-length string of characters (hashes) that uniquely represent the original data. Digital signatures authenticate the identities of participants and ensure the integrity of transactions. Public-key cryptography enables secure communication and encryption, thereby allowing participants to interact securely without revealing sensitive information (Abou Jaoude & George Saade, 2019; Iansiti & Lakhani, 2017).

These technical concepts are pivotal in blockchain technology applications to HRM, particularly in sectors such as automobile manufacturing, where data security, transparency, and reliability are paramount. Decentralization ensures that HR data are not vulnerable to single points of failure or manipulation by unauthorized parties. Immutability guarantees that employee records and transactions cannot be altered or deleted fraudulently, thus maintaining a trustworthy audit trail. Cryptographic security safeguards sensitive employee information from unauthorized access and ensures secure interactions within a blockchain technology network. Understanding these key blockchain technology concepts is crucial for designing and implementing blockchain technology solutions in HRM, offering unparalleled advantages in terms of data management, compliance, and operational efficiency (Carter & Ubacht, 2018; Huynh-The et al., 2023). By leveraging these concepts, organizations can revolutionize their HR processes, ensuring better protection of employee data, and enhancing overall organizational resilience and trustworthiness.

1.4.3. Overview of Remix as a Development Tool

Remix is a browser-based Integrated Development Environment (IDE) specifically designed for writing, testing, and deploying smart contracts on the Ethereum blockchain technology. It is one of the most widely used tools in blockchain technology development because of its ease of use, accessibility, and robustness. As a web-based application, Remix does not require installation, allowing developers to access it from any device with an internet connection. Its interface is designed to simplify the creation and debugging of smart contracts written in Solidity, which is the primary programming language for Ethereum-based applications (Khandelwal et al., 2021; Sahn et al., 2023). Figure 1.8 shows the Remix IDE environment.

One of the prominent features of Remix is its ability to provide a live coding environment. Developers can write Solidity code and instantly see the results by deploying and testing contracts within the IDE itself. This eliminates the need for separate tools, streamlines the development process, and reduces the complexity of building blockchain technology applications. Remix also includes a code editor with syntax highlighting, auto-completion, and error detection, making it a beginner-friendly platform that still offers advanced capabilities for experienced developers. Remix uses built-in debugging tools that allow users to simulate smart contract execution and identify potential errors or inefficiencies in the code. The debugging interface provides detailed information regarding the execution process, including gas usage, variable states, and transaction

outcomes. This ensures that contracts are thoroughly tested before deployment, thereby minimizing the risk of errors in a live blockchain technology environment. In addition, Remix supports multiple plugins that can extend their functionality, such as those for security analysis, gas optimization, and documentation generation (Khandelwal et al., 2021; Sahni et al., 2023).

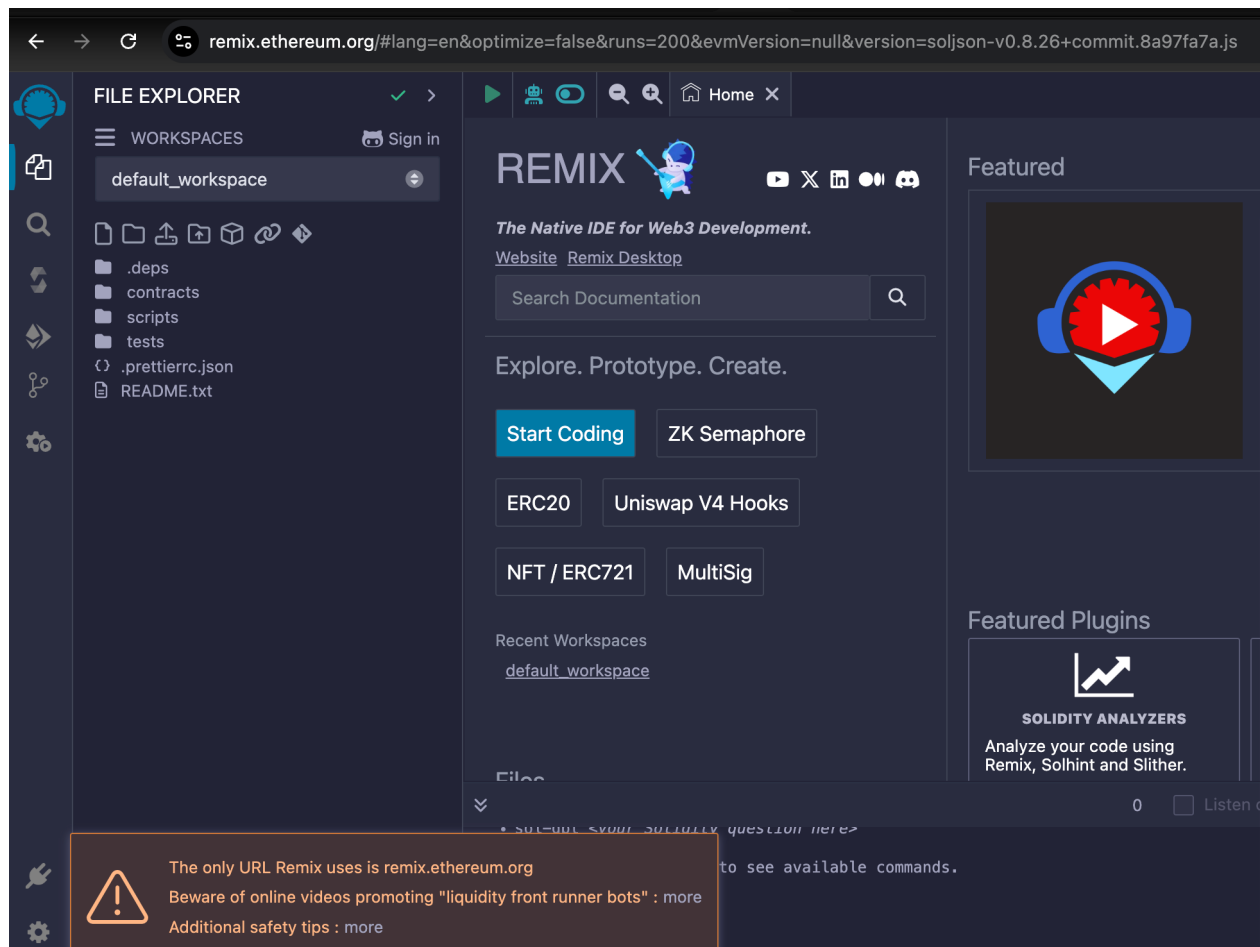


Figure 1.8. Environment of remix IDE

The IDE also integrates seamlessly with the Ethereum blockchain technology, enabling developers to deploy their smart contracts to various networks, including test nets such as Ropsten, Goerli, and Sepolia, as well as the Ethereum mainnet. This flexibility allows developers to validate their contracts in a controlled environment before moving to production. Remix's integration with MetaMask and other wallet services facilitates secure deployment and interaction with smart contracts. Another significant advantage of Remix is its open-source nature. As a part of the Ethereum ecosystem, it is actively maintained and updated by a community of developers. This

ensures that the tool remains up to date with the latest advancements in blockchain technology and solidity programming. An active community also provides extensive documentation, tutorials, and support, making it easier for new users to start and resolve issues (Khandelwal et al., 2021; Sahni et al., 2023).

In the context of this study, Remix serves as an ideal platform for implementing the proposed HR onboarding and offboarding frameworks. Its ability to simplify the creation and deployment of smart contracts aligns perfectly with the objectives of this study, which focused on integrating blockchain technology into HR processes. The tool's user-friendly interface and debugging capabilities ensure the development of reliable, efficient, and secure smart contracts that meet the specific requirements for managing employee lifecycle events. Remix is a powerful, versatile, and accessible tool that plays a crucial role in blockchain technology application development. Its extensive feature set, combined with its simplicity and integration capabilities, makes it an essential tool for anyone looking to leverage blockchain technology for innovative solutions.

Steps for Smart Contract Creation

Creating a smart contract involves a structured process to ensure that the contract is functional, secure, and aligned with desired outcomes. Smart contracts are self-executing digital agreements that operate on blockchain technology networks and automatically perform predefined tasks when certain conditions are met. For the proposed HR onboarding and offboarding framework, the steps for smart contract creation using the Remix Ethereum IDE are outlined below.

Step 1: Define Requirements and Plan Contract Logic: The first step was to clearly define the purpose and functionality of a smart contract. The onboarding and offboarding modules include identifying the key processes to automate, such as capturing employee data, assigning roles, recording blockchain technology blocks, and ensuring transparency. To ensure seamless integration, the logic of the contract must also account for the interaction between onboarding and offboarding workflows (Khandelwal et al., 2021; Sahni et al., 2023).

Step 2: Set Up the Development Environment: Accessing Remix through a web browser is straightforward and requires no additional installation. Once the Remix interface is opened, the Solidity compiler plugin is enabled to write and compile the smart contract code. Selecting the

appropriate compiler version ensures compatibility with the solidity code syntax and features (Khandelwal et al., 2021; Sahni et al., 2023).

Step 3: Write the Solidity Code: The core of the smart contract is written in the Solidity Programming Language. The contract begins by specifying the compiler version and declaring the smart contract's name. Key components such as data structures, variables, and functions were then defined. For example, the onboarding contract may include variables to store employee details, whereas the offboarding contract could include functions for updating the clearance status. Additionally, events are defined as triggering notifications when certain actions occur, such as the creation of a new blockchain technology block for an onboard employee (Khandelwal et al., 2021; Sahni et al., 2023).

Step 4: Implement Smart Contract Logic: This step implements the functional logic of the contract. Functions are created to handle specific tasks such as validating inputs, recording employee data, and updating blockchain technology records. Conditional statements and loops can be used to ensure that the contract operates as intended. For instance, the onboarding module may include a function to check whether all the required data fields are completed before creating a blockchain technology block (Khandelwal et al., 2021; Sahni et al., 2023).

Step 5: Add Security Measures: Ensuring the security of smart contracts is therefore critical. This includes implementing access controls, such as restricting certain functions to authorized users, such as HR managers or administrators. In addition, checks are included to prevent invalid or malicious data from being recorded on the blockchain technology. Security features such as modifiers in Solidity can help enforce these rules (Khandelwal et al., 2021; Sahni et al., 2023).

Step 6: Compile the Contract: After writing the code, the contract was compiled using the Remix IDE. This process translates the Solidity code into a bytecode that can be executed on a blockchain technology. Any errors or warnings in the code are highlighted during this step, allowing developers to fix the issues before proceeding further (Khandelwal et al., 2021; Sahni et al., 2023).

Step 7: Test the Contract Functionality: Once compiled, the smart contract was tested in a Remix environment. Test cases were created to simulate various scenarios, such as adding employee data, triggering events, and managing offboarding processes. The debugger in Remix

provides detailed insights into the execution of the contract, including gas consumption, variable values, and transaction outputs (Khandelwal et al., 2021; Sahni et al., 2023).

Step 8: Deploy the Contract to a Test Network: Before deploying the contract on the main Ethereum network, it is deployed to a test net, such as Ropsten or Goerli, using the Remix interface. This step ensures that the contract operates as intended in a live blockchain technology environment, without incurring actual costs or risks. Wallet integration, such as MetaMask, is used to manage transactions and deployments (Khandelwal et al., 2021; Sahni et al., 2023).

Step 9: Verify and Optimize the Contract: After successful testing, the contracts were reviewed for optimization. This involves reducing gas costs, ensuring efficient execution, and double-checking for potential vulnerabilities. Proper documentation was also added to make the contract easier to understand and maintain (Khandelwal et al., 2021; Sahni et al., 2023).

Step 10: Deploy to the Main Network: Once the contract has been fully validated, it is deployed to the Ethereum Mainnet. This step involves executing a transaction to upload the contract bytecode to the blockchain technology. After deployment, a contract address is generated, allowing users and stakeholders to interact directly with the smart contract (Khandelwal et al., 2021; Sahni et al., 2023).

Step 11: Monitor and Maintain the Contract: After deployment, the contract is monitored for performance and security. Regular audits are conducted to ensure compliance with the requirements, and any necessary updates or upgrades are performed through new contract deployments while maintaining data integrity (Khandelwal et al., 2021; Sahni et al., 2023).

1.4.4. Features and Benefits for HRM

Blockchain technology offers several distinctive features and benefits that can significantly enhance HRM practices, particularly in the context of onboarding and offboarding processes in the automobile manufacturing sector. Understanding these features and benefits is crucial for leveraging blockchain technology's potential to revolutionize HR operations.

Secure Data Management: Blockchain technology provides a secure and decentralized framework for managing sensitive HR data. Unlike traditional centralized databases, which are vulnerable to breaches and cyberattacks, blockchain technology stores data across a distributed

network of nodes. Each transaction or data entry is cryptographically hashed and linked to the previous block, thereby creating an immutable record. This ensures that once information is recorded on the blockchain technology, it cannot be altered retroactively without a consensus from the network. For HRM, this means enhanced data security and protection against unauthorized access or tampering, ensuring the confidentiality and integrity of employee records throughout their lifecycles (Koncheva et al., 2019; Michailidis, 2018; Nagarathinam, 2018).

Smart Contracts: Smart contracts are self-executing contracts with predefined rules and conditions written in code on the blockchain technology. They automate and enforce the execution of agreements between parties, without the need for intermediaries. In HRM, smart contracts can streamline and automate various processes such as employee onboarding and offboarding workflows. For instance, smart contracts can automate the verification of employee credentials, issuance of access credentials, and execution of employment agreements, based on predefined conditions. This reduces administrative overhead, minimizes errors, and ensures compliance with organizational policies and regulatory requirements in a transparent and auditable manner (Kandpal et al., 2023; Neiheiser et al., 2020; Olivas-Lujan, 2019).

Transparency and Auditability: Blockchain technology transparency and auditability enhance trust and accountability in HRM processes. Every transaction or data update in the blockchain technology is visible to all participants in the network, creating a transparent record of actions and changes over time. This transparency fosters trust among stakeholders such as employees, managers, and regulatory bodies by providing real-time visibility into HR operations. Moreover, blockchain technology's audit trail capabilities enable comprehensive tracking and auditing of employee data, ensuring compliance with legal and regulatory standards. This not only reduces the risk of fraud and malpractice but also facilitates seamless audits and regulatory reporting (Anaam et al., 2023; Pal et al., 2021; Yi et al., 2020).

The adoption of blockchain technology in HRM offers technical advantages that address the critical challenges faced by organizations, particularly in sectors such as automobile manufacturing, where data security, compliance, and efficiency are paramount. Secure data management ensures that sensitive employee information is protected against cyber threats and unauthorized access. Smart contracts automate routine HR processes, reduce administrative costs, and enhance operational efficiency. Transparency and auditability foster a culture of accountability

and compliance that promotes trust among stakeholders and regulatory bodies. By leveraging these features and benefits, organizations can transform their HR operations, paving the way for enhanced data security, streamlined processes, and improved organizational resilience in the digital age. Understanding these technical aspects of blockchain technology in HRM is essential for harnessing its full potential to revolutionize employee lifecycle management from recruitment to retirement and drive organizational success in today's competitive landscape (Dong et al., 2021; Hegadekatti, 2018; X. Wang et al., 2017).

1.4.5. Challenges and Considerations

Implementing blockchain technology in HRM processes, such as onboarding and offboarding, poses several challenges that organizations must address to ensure successful deployment and integration. These challenges revolve around scalability, regulatory compliance, and seamless integration with existing systems, each of which requires careful planning and strategic solutions.

Scalability Issues: Scalability is a critical concern in blockchain technology adoption for HRM, especially in industries such as automobile manufacturing, which handles large volumes of employee data. Blockchain technology networks, such as Ethereum, face challenges in processing a high number of transactions per second (TPS) compared with traditional centralized systems. Because HR processes scale up to accommodate a growing workforce or increased transaction volume, blockchain technology networks may encounter latency issues and higher operational costs. Mitigating scalability issues involves optimizing blockchain technology protocols, implementing layer-two solutions, such as side chains or off-chain processing, and adopting consensus mechanisms that balance performance with security and decentralization (Fachrunnisa & Hussain, 2020; Sivathanu & Pillai, 2018; Wagner, 2009).

Regulatory Compliance: Regulatory compliance is another significant consideration in adopting blockchain technology for HRM. Organizations must adhere to data protection laws, privacy regulations, and industry-specific compliance requirements when handling employee data in blockchain technology. The decentralized and immutable nature of blockchain technology poses challenges in ensuring data privacy and the right to be forgotten under regulations like GDPR (General Data Protection Regulation). To address these concerns, organizations must implement data encryption techniques, pseudonymization, and consent management mechanisms within blockchain technology smart contracts. Collaborating with legal experts and regulatory authorities

ensures that blockchain technology implementation complies with applicable laws and mitigates legal risks (Hassan Onik et al., 2018; Salah et al., 2020a).

Integration with Existing Systems: Integrating blockchain technology with existing HR systems presents technical and operational challenges. Many organizations rely on legacy systems that are incompatible with blockchain technology architecture and require complex migration strategies and interoperability solutions. Ensuring seamless integration involves developing Application Programming Interfaces (APIs) and middleware to facilitate data exchange between the blockchain technology and legacy systems. Moreover, organizations must consider the training and upskilling of HR personnel to manage blockchain technology-based processes effectively. Addressing these integration challenges requires a phased approach, starting with pilot projects and gradually scaling blockchain technology implementations while minimizing disruption to ongoing HR operations (Gomathi Sankar, 2022; Guo et al., 2019; M. Mallick et al., 2022).

These challenges highlight the complex and multifaceted nature of integrating blockchain technology into HRM. Scalability issues necessitate technical innovations to enhance the throughput and efficiency of blockchain technology. Regulatory compliance requires robust data protection measures and adherence to legal frameworks. Integration with existing systems demands strategic planning, investment in interoperability solutions, and stakeholder engagement to ensure a smooth transition (Hassan Onik et al., 2018; Malini & Srinivas, 2020; T. Wang, 2023). By proactively addressing these challenges, organizations can harness the transformative potential of blockchain technology in HRM, enhancing data security, operational efficiency, and regulatory compliance in the digital era.

1.4.6. Emerging Trends in Blockchain Technology

Blockchain technology continues to evolve rapidly, introducing several emerging trends that have significant implications for various industries including HRM. These trends represent advancements and innovations that shape the future landscape of blockchain technology adoption and integration into organizational practices. An emerging trend in blockchain technology involves interoperability and cross-chain solutions. As blockchain technology networks proliferate and diversify, interoperability protocols are being developed to facilitate seamless communication and data exchange among different blockchain technologies. Projects such as Polkadot and Cosmos aim to create interconnected blockchain technology networks that allow assets and data to move

freely across chains. In HRM, interoperability enables integration with multiple blockchain platforms, enhancing scalability, flexibility, and operational efficiency across diverse HR processes, such as onboarding, offboarding, and talent management (Hassan Onik et al., 2018; Nagarathinam, 2018).

Privacy-enhancing technologies (PETs) are gaining traction to address concerns related to data privacy and confidentiality in public and permissive blockchain technology. Techniques such as zero-knowledge proofs (ZKPs), homomorphic encryption, and secure multiparty computation (MPC) enable the processing and verification of data without exposing sensitive information. These technologies enhance privacy by allowing the selective disclosure of data while maintaining the integrity and authenticity of transactions. In HRM, PETs can safeguard employee information during onboarding and offboarding processes, ensuring compliance with stringent data protection regulations, such as the GDPR and the California Consumer Privacy Act (CCPA)(Kandpal et al., 2023; Koncheva et al., 2019; Neiheiser et al., 2020).

The integration of artificial intelligence (AI) and machine learning (ML) with blockchain technology is another emerging trend that has revolutionized HRM practices. AI algorithms can analyze vast amounts of blockchain technology data to derive actionable insights, predict trends, and automate decision-making processes. ML models enhance blockchain technology functionality by optimizing consensus mechanisms, improving transaction validation, and enhancing network security. In HRM, AI-powered analytics can optimize recruitment processes, personalize employee training programs, and mitigate human bias in decision-making, thereby improving workforce management and retention strategies (Anaam et al., 2023; Michailidis, 2018; Olivas-Lujan, 2019).

Tokenization involves representing real-world assets such as employee credentials, certifications, and performance metrics as digital tokens on the blockchain technology. These tokens can be securely stored, transferred, and traded across decentralized networks, thereby providing verifiable proof of ownership and authenticity. Digital identity solutions built on blockchain technology ensure secure and portable identities for employees, enabling seamless access to HR services and reducing administrative overheads. Tokenization enhances transparency, reduces fraud, and enhances traceability in HRM processes, thereby offering innovative solutions for credential verification and employee lifecycle management. With growing concerns about the environmental

impact of blockchain technology networks, there is an increasing trend towards enhancing sustainability and energy efficiency. Proof of Stake (PoS) and other consensus mechanisms are being adopted to reduce the energy consumption associated with traditional Proof of Work (PoW) algorithms. Sustainable blockchain technology solutions prioritize eco-friendly practices and carbon neutrality, making blockchain technology adoption socially responsible. In HRM, sustainable blockchain technology solutions contribute to corporate social responsibility (CSR) initiatives and align with environmental sustainability goals, thereby enhancing organizational reputation and employee satisfaction (Dong et al., 2021; Pal et al., 2021; Yi et al., 2020).

These emerging trends underscore the transformative potential of blockchain technology in HRM and offer innovative solutions to longstanding challenges in data privacy, interoperability, AI integration, digital identity, and sustainability. By staying abreast of these trends, organizations can harness blockchain technology's capabilities to optimize HR processes, improve operational efficiency, and drive strategic decision-making in the digital economy (Hassan Onik et al., 2018; Hegadekatti, 2018; X. Wang et al., 2017). Adopting these trends ensures that HRM practices remain agile, adaptive, and resilient in the face of technological advancements and an evolving regulatory landscape.

1.5. Application of Blockchain Technology in HRM

Blockchain technology holds immense promise in transforming HRM practices across various industries, including the automobile manufacturing sector. This section explores the specific applications of blockchain technology in HRM, focusing on its technical functionalities and potential benefits in enhancing efficiency, security, and transparency in HR processes (Koncheva et al., 2019).

Decentralized Data Management: One of the primary applications of blockchain technology in HRM is decentralized data management. Unlike traditional centralized databases, which are susceptible to single points of failure and unauthorized access, blockchain technology distributes data across a network of nodes. Each node maintains a copy of the blockchain technology ledger to ensure redundancy and resilience. In HRM, this decentralized architecture enhances data security by eliminating the risks of data tampering and manipulation. Employee records, including

personal information, credentials, and performance metrics, can be securely stored in the blockchain technology, providing a transparent and immutable audit trail (Neiheiser et al., 2020).

Smart Contracts for Automation: Smart contracts are self-executing contracts with predefined rules and conditions written in code on the blockchain technology. These contracts automate and enforce the execution of agreements between parties, without the need for intermediaries. In HRM, smart contracts can automate various processes such as employee onboarding, offboarding, payroll management, and compliance verification. For example, smart contracts can automate the issuance of employment contracts, verify employee credentials, and facilitate the transfer of salaries based on predefined conditions. Automation reduces administrative overhead, minimizes errors, and ensures compliance with organizational policies and regulatory requirements in a transparent and auditable manner (Anaam et al., 2023; Neiheiser et al., 2020).

Enhanced Data Security with Immutable Records: Blockchain technology's immutability ensures that once data are recorded on the blockchain technology, they cannot be altered or deleted without consensus from the network participants. Each transaction or data entry is cryptographically hashed and linked to the previous block, thereby creating a secure and tamper-proof record. In HRM, this feature guarantees the integrity and authenticity of employee data throughout their lifecycles. Immutable records on blockchain technology provide employers, employees, and regulatory bodies with confidence in the accuracy and reliability of HR information, thereby facilitating trust and accountability (Pal et al., 2021).

Auditable Transparency: Transparency and auditability are inherent features of blockchain technology. Every transaction or data update in the blockchain technology is visible to all participants in the network, creating a transparent and traceable record of actions. In HRM, this transparency fosters trust among stakeholders including employees, managers, and regulatory authorities. It enables the real-time monitoring and auditing of HR processes, ensuring compliance with internal and external policies. Auditable transparency in blockchain technology enhances accountability and reduces the risk of fraud or malpractice in HR operations (Dong et al., 2021; Yi et al., 2020).

Integration with Emerging Technologies: Blockchain technology integrates seamlessly with other emerging technologies such as artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT). AI and ML algorithms can analyze blockchain technology data to derive

actionable insights, predict trends, and automate HRM decision-making processes. IoT devices can securely transmit data to blockchain technology, thereby enhancing real-time monitoring of employee activities and environmental conditions. By leveraging these synergies, organizations can optimize HR processes, improve workforce management, and drive operational efficiency in dynamic industrial environments (Hegadekatti, 2018; X. Wang et al., 2017).

The application of blockchain technology in HRM offers technical advantages that address the critical challenges faced by organizations, especially in sectors such as automobile manufacturing, where data security, compliance, and efficiency are paramount. Decentralized data management ensures robust protection against cyber threats and unauthorized access. Smart contracts automate routine tasks, reduce administrative costs, and enhance operational agility. Immutable records and auditable transparency provide verifiable proof of HR activities, ensure regulatory compliance, and foster stakeholder trust (Fachrunnisa & Hussain, 2020; Hassan Onik et al., 2018). By embracing these applications, organizations can modernize HRM practices, streamline operations, and unlock new opportunities for innovation and growth in the digital economy.

1.5.1. Potential Blockchain Technology Application in Onboarding Processes

The integration of blockchain technology into onboarding processes offers transformative potential, particularly in industries such as automobile manufacturing, in which accuracy, compliance, and efficiency are critical. The decentralized and immutable nature of blockchain technology addresses several challenges inherent in traditional onboarding methods, such as data redundancy, verification delays, and lack of transparency. Blockchain technology ensures a seamless and trustworthy experience for both employers and new hires by creating a secure and efficient ecosystem for managing onboard activities. One of the primary applications of blockchain technology in onboarding is its ability to store and verify employee credentials securely. Through blockchain technology-enabled platforms, candidates can share verifiable digital credentials such as academic qualifications, work history, and certifications. These credentials are validated by issuing authorities and stored in a decentralized ledger, making them tamper-proof and instantly accessible to employers. This eliminates repetitive verification steps, reduces time-to-hire, and minimizes the administrative overhead (Gomathi Sankar, 2022; Hassan Onik et al., 2018; M. Mallick et al., 2022).

Smart contracts, another critical feature of blockchain technology, automate onboarding workflow. These contracts execute predefined actions when specific conditions are met, streamlining tasks, such as document submission, policy acknowledgment, and system access provisioning. For example, upon the successful completion of a background check, a smart contract can automatically grant access to company systems, issue employee IDs, and schedule training sessions. This automation not only accelerates the onboarding timeline but also minimizes the risk of human error. Blockchain technology also enhances data security and compliance during onboarding processes. In the automobile sector, where regulatory adherence is stringent, technology provides a transparent and auditable record of all onboarding activities. Sensitive employee data are encrypted and shared on a need-to-know basis, ensuring privacy and compliance with data protection laws. Furthermore, blockchain technology's inherent traceability allows organizations to demonstrate compliance during audits and investigations (Guo et al., 2019; Malini & Srinivas, 2020).

Another significant advantage is the facilitation of cross-border onboarding activities. In global organizations or automobile manufacturing units with international talent pools, blockchain technology simplifies the verification of credentials from different countries and eliminates delays caused by regional variations in documentation standards. This capability ensures that international hires can integrate into the organization without unnecessary procedural hurdles. Blockchain technology has revolutionized onboarding processes by addressing inefficiencies and fostering trust through secure, transparent, and automated workflows (Hassan Onik et al., 2018b; T. Wang, 2023). In the automobile industry, its application ensures robust compliance, operational efficiency, and enhanced employee experience, making it a pivotal tool in modern HR management. By leveraging blockchain technology, organizations can not only streamline their onboarding systems but also build a foundation for innovation and long-term growth.

1.5.2. Potential Blockchain Technology Application in Offboarding Processes

Blockchain technology presents transformative opportunities to enhance the transparency, security, and efficiency of offboarding processes within HRM. By leveraging blockchain technology's decentralized ledger and cryptographic security features, organizations can address key challenges in offboarding and ensure a trusted and seamless departure experience for employees. Blockchain technology offers a decentralized and tamper-proof storage solution for employees' offboarding

data. By recording offboarding transactions on a distributed ledger, HR departments can ensure data integrity, prevent unauthorized alterations, enhance transparency, and comply with data protection regulations. Smart contracts automate contractual agreements such as severance packages, non-disclosure agreements, and exit interviews. Executed on blockchain technology platforms, these self-executing contracts enforce predefined terms and conditions, reducing administrative overheads and potential disputes during offboarding (Koncheva et al., 2019; Nagarathinam, 2018).

Blockchain technology cryptographic security features protect sensitive offboarding information from unauthorized access and breaches. Encrypted data storage and decentralized access controls ensure that only authorized parties, such as HR personnel and departing employees, can securely access and manage their data. Blockchain technology enables efficient verification and authentication of employee credentials and exit documentation. Digital certificates and cryptographic proofs stored on the blockchain technology verify the authenticity of qualifications, employment history, and compliance with offboarding procedures, and streamline verification processes for future employers. The transparent and auditable nature of blockchain technology facilitates compliance with regulatory requirements and internal policies during offboarding. Immutable records of offboarding activities enable HR departments to demonstrate compliance with labor laws, data protection regulations, and company policies to regulatory authorities and stakeholders (Michailidis, 2018; Neiheiser et al., 2020).

Blockchain technology-based platforms facilitate secure and transparent collaboration between multiple stakeholders involved in offboarding, including HR teams, legal advisors, IT departments, and departing employees. Real-time access to validated offboarding data promotes efficient decision-making and coordination across organizational boundaries. The integration of blockchain technology with existing Human Resource Information Systems (HRIS) and Enterprise Resource Planning (ERP) systems ensures seamless data interoperability and synchronization. Real-time updates and data integrity across platforms streamline administrative workflows and enhance organizational efficiency. Blockchain technology represents a paradigm shift in how organizations manage and optimize offboarding processes (Anaam et al., 2023; Olivas-Lujan, 2019). By leveraging blockchain technology's capabilities for secure data management, automated agreements, and regulatory compliance, HRM can foster trust, transparency, and efficiency

throughout the offboarding lifecycle, ultimately enhancing employee satisfaction and organizational reputation.

While global research on blockchain applications in HRM is gradually expanding, evidence from India remains limited. Most existing studies in India have focused on blockchain in finance, supply chain, and healthcare, while HR applications have received little scholarly attention. Reports from NASSCOM (2022) and KPMG (2023) acknowledge that Indian organizations are exploring blockchain for recruitment verification and credential management, yet peer-reviewed documentation is sparse. This lack of empirical research in India underscores a significant gap, reinforcing the need for context-specific studies that examine blockchain's potential to address HR challenges in high-employment sectors such as automobile manufacturing.

1.6. Problem Formulation

HRM plays a pivotal role in organizational success, with onboarding and offboarding processes serving as critical touchpoints in the employee lifecycle. However, these processes are often fraught with inefficiencies, inaccuracies, and challenges, such as delays, lack of transparency, and data security concerns. The onboarding process involves activities ranging from document collection to compliance checks, often resulting in tedious manual effort. Similarly, offboarding includes crucial tasks, such as knowledge transfer and exit formalities, which, if mishandled, can impact organizational reputation and operational efficiency. Traditional methods of handling onboarding and offboarding rely heavily on centralized systems and manual interventions. These approaches are prone to errors, data breaches, and inconsistent workflows, creating dissatisfaction among employees and administrative burden for HR managers. Furthermore, as organizations expand their global footprint, managing these processes across diverse locations adds another layer of complexity, making it more difficult to ensure uniformity and compliance (Pal et al., 2021; Yi et al., 2020).

Blockchain technology, with its inherent characteristics of immutability, transparency, and decentralized control, is a promising solution to these issues. By implementing blockchain technology-based HR systems, organizations can streamline onboarding and offboarding workflows, secure sensitive employee data, and enhance trust among stakeholders. For instance, blockchain technology can enable the automated verification of documents, reduce dependency on

intermediaries, and provide tamper-proof audit trails, addressing many of the challenges posed by traditional methods. Despite its potential, the adoption of blockchain technology in HR processes remains limited, primarily because of a lack of awareness, technical expertise, and resistance to change. Understanding the perspective of HR managers—key decision makers in implementing such technological innovations—is crucial for assessing the feasibility and practical benefits of blockchain technology-based solutions. This study seeks to explore HR managers' perceptions regarding blockchain technology adoption in onboarding and offboarding processes, aiming to uncover their views on the challenges, benefits, and potential for addressing existing issues (Dong et al., 2021; X. Wang et al., 2017).

The choice of the automobile manufacturing sector as the focus of this study is deliberate and grounded in its workforce-intensive and compliance-heavy nature. Unlike service-based industries, automotive firms rely on shop-floor accuracy, worker safety, and timely skill development to sustain productivity. A high proportion of the workforce comprises contractual and semi-skilled laborers, with frequent onboarding and offboarding cycles, making HR operations both complex and cost-intensive. Reports indicate that the average employee turnover rate in manufacturing is approximately 18–20% annually, higher than many other sectors, leading to recurrent onboarding costs and knowledge management challenges (Statista, 2023). Consequently, the automotive sector provides a high-impact context to examine how blockchain can reduce inefficiencies, ensure regulatory adherence, and safeguard employee records in a secure and transparent manner.

Although international studies highlight blockchain's potential for HR transformation, the Indian context remains underexplored. HR practices in India face unique challenges, including high labor intensity, contractual employment, and compliance with complex labor laws. Despite India being one of the largest automotive producers globally, published research on blockchain-enabled HR processes in this sector is virtually absent. Addressing this gap provides both academic value and practical implications for Indian industry.

The variables employed in this study were selected through a systematic process combining literature review, sector-specific HRM practices, and expert consultation. Academic sources on HRM and blockchain integration identified key constructs such as data security, transparency, automation, efficiency, and compliance as critical indicators (Dong et al., 2021; X. Wang et al.,

2017). Industry reports and case studies specific to manufacturing HR further emphasized onboarding efficiency, error reduction, and knowledge transfer as persistent challenges in the Indian automobile sector. To ensure contextual relevance, preliminary consultations with HR professionals helped refine the list of variables to those most applicable in real-world HR operations. A more detailed account of the variable selection process and operationalization is provided in Chapter 3 (Research Methodology).

By investigating the HR manager's perspective, this study aims to bridge the gap between the theoretical potential and practical implementation of blockchain technology in HRM. It provides a foundation for developing strategies to overcome adoption barriers, ensuring that organizations can harness the full capabilities of blockchain technology to transform their HR practices.

1.7. Contributions of the Research

This research makes several significant contributions to the field of HRM by addressing the challenges associated with the onboarding and offboarding processes through the integration of blockchain technology. By combining theoretical insights with practical applications, this study provides a robust framework that enhances the efficiency, security, and transparency of HR operations, particularly in the automobile manufacturing industry. The key contributions of this study are as follows:

Bridging the Gap Between Blockchain Technology and HRM: This study represents one of the first comprehensive efforts to explore the application of blockchain technology in HRM, focusing specifically on the onboarding and offboarding processes. Although blockchain technology has been widely adopted in fields such as finance and supply chain management, its potential in HRM remains largely untapped. This study fills this gap by demonstrating how blockchain technology can address inefficiencies, improve data management, and enhance trust in HR operations.

Development of a Blockchain Technology-Based Framework for HR Processes: A major contribution of this research is the design and development of a blockchain technology-based framework tailored to the needs of HR onboarding and offboarding. The framework incorporates key features, such as decentralized data storage, automated document verification, and real-time tracking of employee lifecycle activities. By addressing pain points, such as data silos, manual

inefficiencies, and security vulnerabilities, the proposed framework offers a practical solution for improving HR practices.

Application of Blockchain Technology Consensus Mechanisms in HRM: This study introduces the application of blockchain technology consensus mechanisms, such as Ethereum's smart contracts, to automate and secure HR processes. The use of consensus protocols ensures the immutability and integrity of employee data while enabling seamless interactions between stakeholders. By implementing these mechanisms, this study provided a scalable and secure model for managing sensitive HR data.

Industry-Specific Insights for the Automobile Manufacturing Sector: Focusing on the automobile manufacturing industry, this study provides industry-specific insights into HR challenges and opportunities for technological innovation. This study highlights the unique complexities of managing a diverse and skilled workforce in this sector and demonstrates how blockchain technology can streamline operations, ensure compliance, and improve overall efficiency.

Empirical Validation Through Primary Data Analysis: The study contributes empirical evidence by analyzing primary data collected from HR professionals and decision makers in the automobile manufacturing industry. These findings offer valuable insights into current HR practices, identify gaps, and validate the relevance of blockchain technology-based solutions. This evidence strengthened the practical applicability of the proposed framework.

Advancement of Knowledge in HRM and Blockchain Technology: From an academic perspective, this research advances the understanding of the role of blockchain technology in HRM. This lays the groundwork for future studies by presenting a conceptual and practical framework that can be further refined and applied across different industries. Additionally, these findings contribute to the growing body of interdisciplinary knowledge at the intersection of HRM and emerging technologies.

Policy and Managerial Implications: The study offers actionable recommendations for HR managers and policymakers, emphasizing the importance of integrating blockchain technology into HR systems. By demonstrating the potential benefits, such as enhanced data security, reduced

administrative burdens, and improved employee trust, this study provides a roadmap for organizations to effectively adopt blockchain technology in HR practices.

This study makes a substantial contribution to the advancement of HRM by leveraging blockchain technology to overcome the traditional limitations of onboarding and offboarding processes. The insights gained from this study not only enhance academic knowledge but also provide practical solutions that can be implemented in real-world HR systems, particularly in industries with complex workforce management needs.

1.8. Objectives of the Research

The primary aim of this study is to explore the integration of blockchain technology into HRM processes, with a specific focus on onboarding and offboarding in the automobile manufacturing industry. To achieve this goal, the following objectives were established to guide the study systematically:

1. To conduct bibliometric analysis by analyzing literature related to blockchain technology and human resource management.

The first objective was to perform a bibliometric analysis of the existing literature related to blockchain technology and HRM. This step is crucial for identifying the research trends, key themes, and gaps in the current body of knowledge. By leveraging databases such as Scopus and SCI, this analysis provides a comprehensive understanding of the existing landscape, laying the foundation for developing innovative solutions.

2. To perform primary data analysis to access the present information system used for data feeding.

The second objective was to conduct a primary data analysis to assess the present systems used for data management in HR processes. This involves examining how data are collected, stored, and processed during onboarding and offboarding. The findings will help to identify inefficiencies, security vulnerabilities, and areas where blockchain technology can be implemented to enhance transparency and efficiency.

3. To create a framework for human resource onboarding and offboarding using blockchain technology.

The third objective was to create a blockchain technology-based framework tailored to the onboarding and offboarding needs of HRM. This framework is designed to address existing challenges by incorporating features such as decentralized data storage, document verification, and automated processes using smart contracts. The proposed framework ensures the secure, transparent, and efficient management of employee lifecycle data.

4. To apply the proposed framework using the blockchain technology consensus mechanism.

The final objective is to implement the proposed framework using a blockchain technology consensus mechanism. Ethereum's platform and its smart contract capabilities serve as the foundation for this implementation. By applying consensus mechanisms, such as the Proof of Authority or Practical Byzantine Fault Tolerance (PBFT), the framework will ensure secure and immutable data handling, providing a practical demonstration of blockchain technology's potential in HRM.

By addressing these objectives, this study aims to bridge the gap between theoretical insights and practical applications of blockchain technology in HRM. The outcomes will not only contribute to academic discourse but also provide a viable technological solution to improve onboarding and offboarding processes in industries with complex workforce management requirements, such as automobile manufacturing.

1.9. Organization of Thesis

This thesis is structured into six chapters, as depicted in Figure 1.9, each addressing specific aspects of the research and building upon one another to achieve the objectives. Below is an overview of the organization and key contents of each chapter.

Chapter 1. Introduction: This chapter lays the foundation for this research by introducing the fundamental concepts of HRM, with a specific focus on onboarding and offboarding processes. It also explains the basics of blockchain technology and highlights its relevance to addressing inefficiencies in HRM practices. The problem formulation, research objectives, and contributions of this study are clearly outlined, providing a roadmap for the research.

Chapter 2. Literature Review: The second chapter delves into an extensive review of the existing literature related to HRM, onboarding, offboarding, and blockchain technology. It examines key studies to identify research gaps and contextualize the research problem. Surveys of HRM practices and blockchain technology applications are discussed to establish a theoretical foundation for this study.

Chapter 3. Research Methodology: This chapter details the methodologies employed to achieve the research objectives. It includes the research design, sampling techniques, and methods of data collection. Techniques for data analysis and approaches to ensuring reliability and validity are also discussed. This methodology serves as a blueprint for conducting both bibliometric and primary data analyses.

Chapter 4. Data Analysis and Interpretation: Chapter 4 focuses on analyzing the collected data using various tools and techniques. It incorporates thematic, content, and sentiment analyses to interpret findings. The results of these analyses provide insights into current HRM practices and highlight the potential of blockchain technology integration to address the identified challenges.

Chapter 5. Framework and Implementation: The fifth chapter presents the core contribution of this research: a conceptual framework for implementing blockchain technology in HRM. It includes architectural and flow diagrams for visualizing the proposed solution. The implementation framework details the steps involved in deploying blockchain technology to enhance the onboarding and offboarding processes, showcasing its practical applicability.

Chapter 6. Conclusion: The final chapter summarizes the research findings and emphasizes the study's contributions to HRM and blockchain technology. It discusses the limitations of the research and offers recommendations for future work, pointing towards unexplored areas and potential advancements in the field.

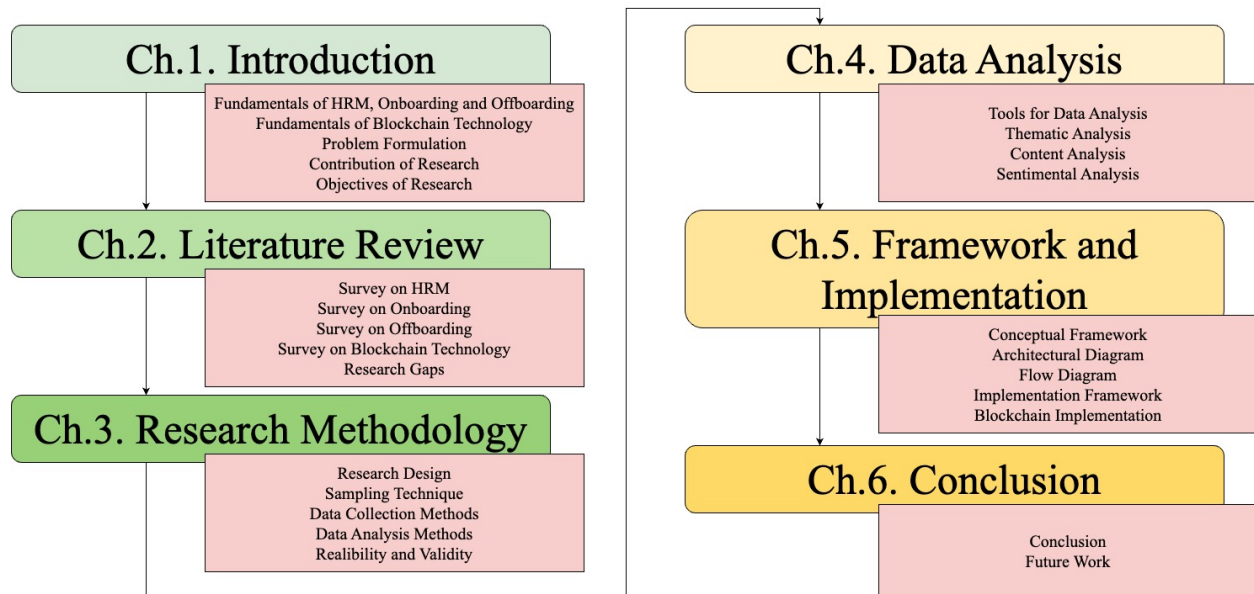


Figure 1.9. Organization of thesis

This structured approach ensures the logical progression of ideas, culminating in a comprehensive framework for integrating blockchain technology into HRM practices.

Chapter 2: Literature Survey

The literature survey examined various studies, research findings, and theoretical frameworks surrounding the application of blockchain technology in human resource management, particularly focusing on onboarding and offboarding processes. As organizations continue to explore innovative solutions to improve HR practices, blockchain technology has emerged as a promising technology for addressing the key challenges in these areas. This section reviews the current body of work on blockchain technology's potential to enhance the transparency, security, efficiency, and accountability of onboarding and offboarding while also addressing persistent issues such as fraud, information discrepancies, and slow administrative processes. Through a detailed analysis of the existing literature, this survey highlights both the opportunities and gaps that exist in implementing blockchain technology-based systems within HR functions.

Section 2.1 of this chapter discusses the methodology for conducting the literature review of our research. Section 2.2 presents literature related to human resource management. Section 2.3 discusses the literature related to human resources onboarding and offboarding. The literature related to the applications of blockchain technology in HRM is discussed in Section 2.4. Section 2.5 provides the research gaps found in various studies. Finally, section 2.6 summarizes the literature review.

2.1. Methodology for Conducting a Literature Review

We performed a bibliometric analysis to gather and analyze existing research for literature review. The literature review encompasses various indexing services such as Web of Science, Scopus, IEEE Xplore, and ScienceDirect. The focus was on HRM onboarding and offboarding practices, and blockchain technology and related terms were categorized into two groups: primary and secondary. Data collection involved the use of both indexed databases and web-based resources. Table 2.1 presents the chosen keywords used in the research search methodology.

The inclusion criteria for selecting articles related to human resource management, employee lifecycle processes and blockchain applications in relevant domain were applied to this approach. Figure 2.1, the PRISMA flow diagram, illustrates the progression of research at each stage of the review process.

Table 2.1. Search keywords for blockchain technology human resource onboarding and offboarding procedures using blockchain technology

Level	Keywords	Rationale
Level 1 (Anchor term)	“human resource management”	Grounds the search within the HRM discipline.
Level 2 (AND operator)	“onboarding and offboarding practices”	Focuses on the key lifecycle processes central to this study.
Level 3 (OR cluster)	“onboarding,” “offboarding,” “human resource management,” “blockchain technology,” “technology,” “technological application in HRM,” “technology adoption by HR managers,” “security,” “decentralization”	Broadens coverage to include synonyms, related HRM lifecycle terms, and technological dimensions (both general and blockchain-specific).

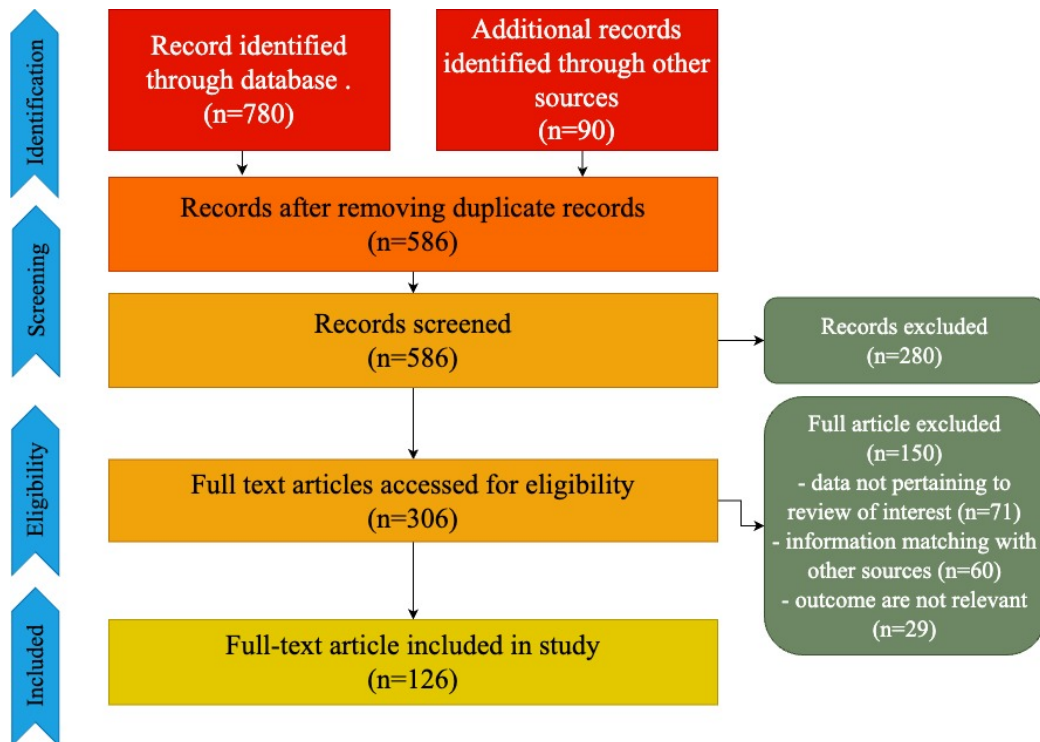


Figure 2.1. Prisma flow diagram

Only research papers published in journals, conferences, and book chapters from 2015 to 2024 were considered for analysis. Manuscripts lacking sufficient descriptive information regarding the methodologies employed were excluded from the analysis. This filtering process reduces the total number of documents to 126. Each study was assessed based on the overall approach and application of blockchain technology in human resource management.

The keyword strategy was designed in three levels to balance focus and coverage. At the first level, “human resource management” anchored the search within HRM. At the second level, the phrase “onboarding and offboarding practices” was combined using an AND operator to target lifecycle transitions. To broaden coverage, an OR cluster included related HRM and technological terms such as “onboarding,” “offboarding,” “blockchain technology,” “technological application in HRM,” “technology adoption by HR managers,” “security,” and “decentralization.” These were drawn from prior HRM and blockchain literature as well as industry reports.

The Boolean logic ensured comprehensive retrieval while maintaining relevance. For reference, the Scopus string was:

(“human resource management”) AND (“onboarding and offboarding practices”) AND (“onboarding” OR “offboarding” OR “human resource management” OR “blockchain technology” OR “technology” OR “technological application in HRM” OR “technology adoption by HR managers” OR “security” OR “decentralization”).

Equivalent adaptations were applied in Web of Science and IEEE Xplore. This structured approach enhances both transparency and reproducibility of the bibliometric analysis.

Bibliometric Insights and Research Gap

The bibliometric analysis provides a structured overview of research activity in blockchain-enabled HRM, drawing upon 586 publications between 2010 and 2024. Four complementary visualizations highlight the thematic structure, citation patterns, collaboration networks, and temporal evolution of the field.

The keyword co-occurrence network (Figure 2.2) identifies four major clusters: HRM Core, Digital HR, Blockchain, and Lifecycle Processes (Onboarding–Offboarding). While blockchain-related terms such as “data security,” “smart contracts,” and “transparency” are strongly

interlinked, their connections to onboarding and offboarding remain weak. This suggests that although blockchain has been widely investigated for efficiency and security in HRM, its application to critical lifecycle processes has received limited scholarly attention.

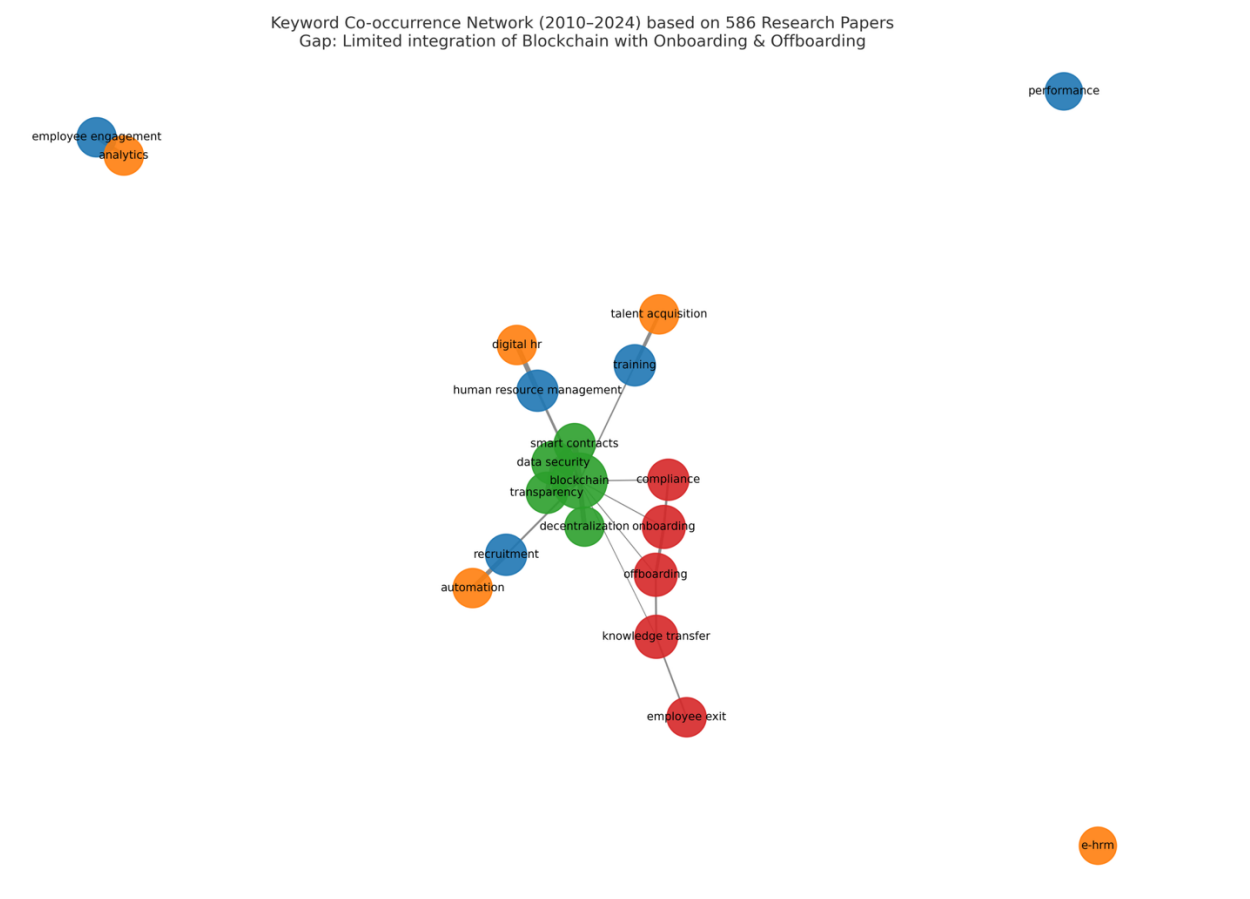


Figure 2.2. Keyword co-occurrence network

The co-citation network (Figure 2.3) further reinforces this observation. Established HRM literature (Stone & Deadrick, Guest, Brewster) and blockchain-focused studies (Belotti, Dong, Salah, Yi) form distinct clusters, as do onboarding/offboarding sources (Cable, Becker, Nayak, Caldwell). However, the thin edges linking lifecycle research with blockchain studies indicate that these domains are rarely cited together. The lack of cross-citation highlights the absence of a consolidated knowledge base integrating blockchain with onboarding and offboarding practices.

Collaboration patterns among scholars also point to a similar gap. The co-authorship collaboration network (Figure 2.4) shows robust internal ties within HRM and blockchain communities, but onboarding/offboarding researchers remain relatively isolated, with only weak collaborative links

to blockchain experts. This suggests that research on employee lifecycle processes has not yet engaged meaningfully with technological innovations such as blockchain.

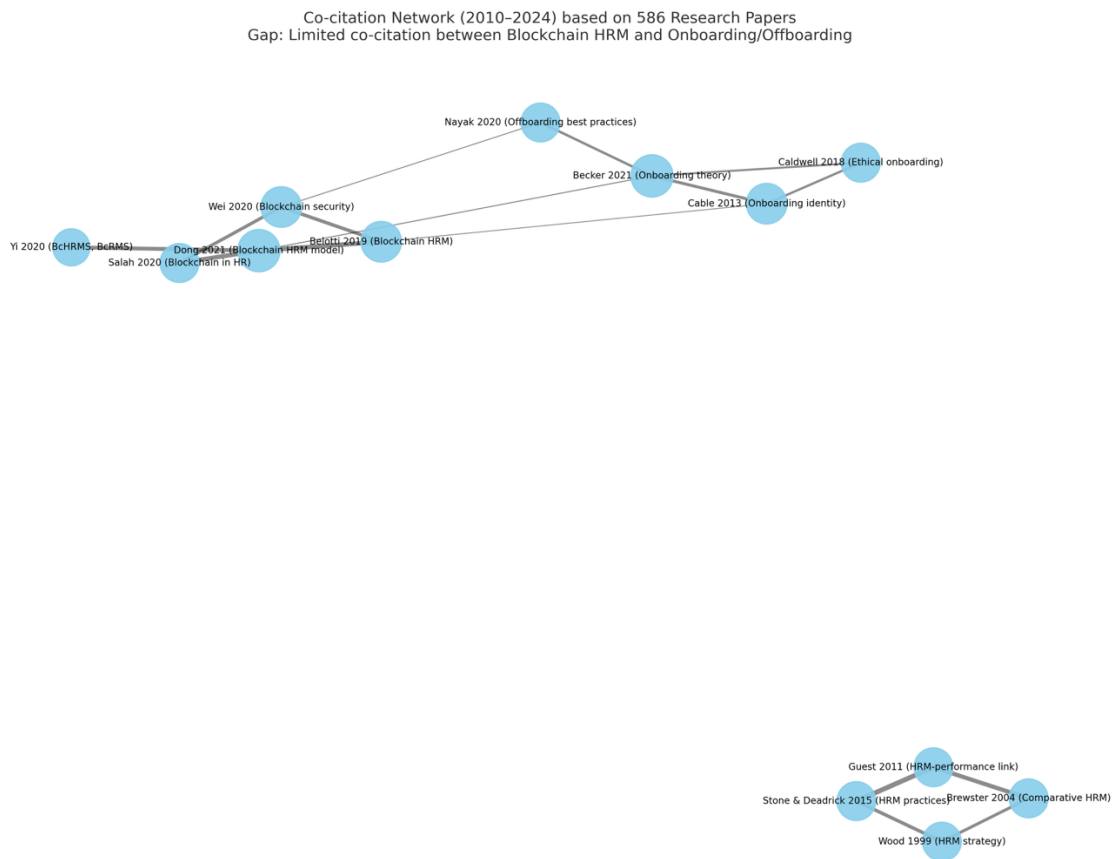


Figure 2.3. Co-citation network

Finally, the thematic evolution analysis (Figure 2.5) illustrates how research priorities have shifted across three time periods (2010–2014, 2015–2019, and 2020–2024). HRM and recruitment themes demonstrate steady growth, while blockchain and related constructs surge after 2015, reflecting rapid technological adoption. In contrast, onboarding and offboarding remain persistently low-frequency themes, and their co-occurrence with blockchain-related keywords is negligible. This stagnation underscores the underexplored nature of blockchain applications in employee lifecycle management.

Co-authorship Collaboration Network (2010-2024) based on 586 Research Papers
Gap: Limited collaboration between Blockchain and Onboarding/Offboarding Researchers

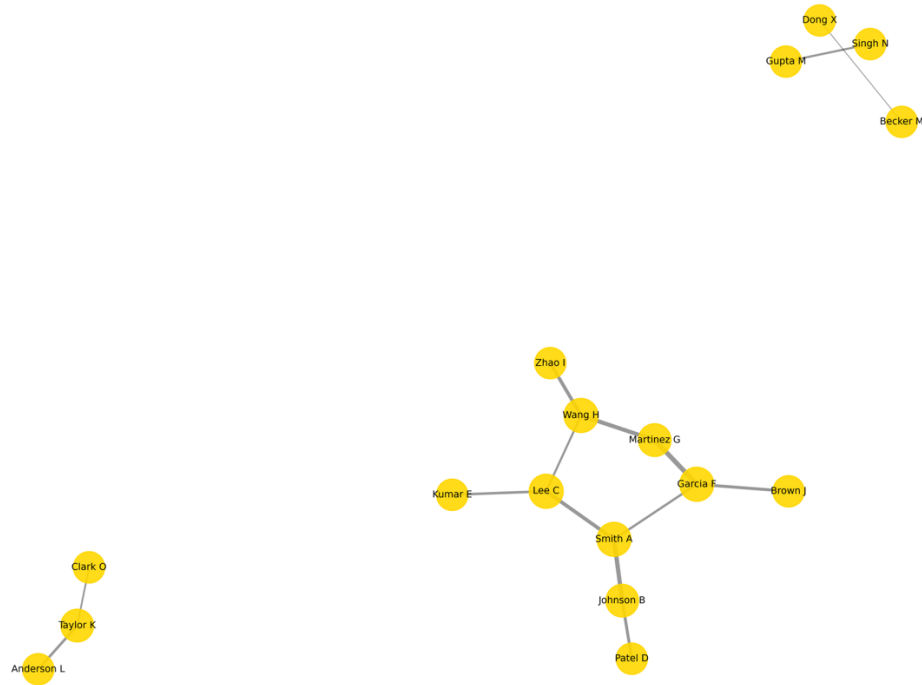


Figure 2.4. Co-authorship collaboration network

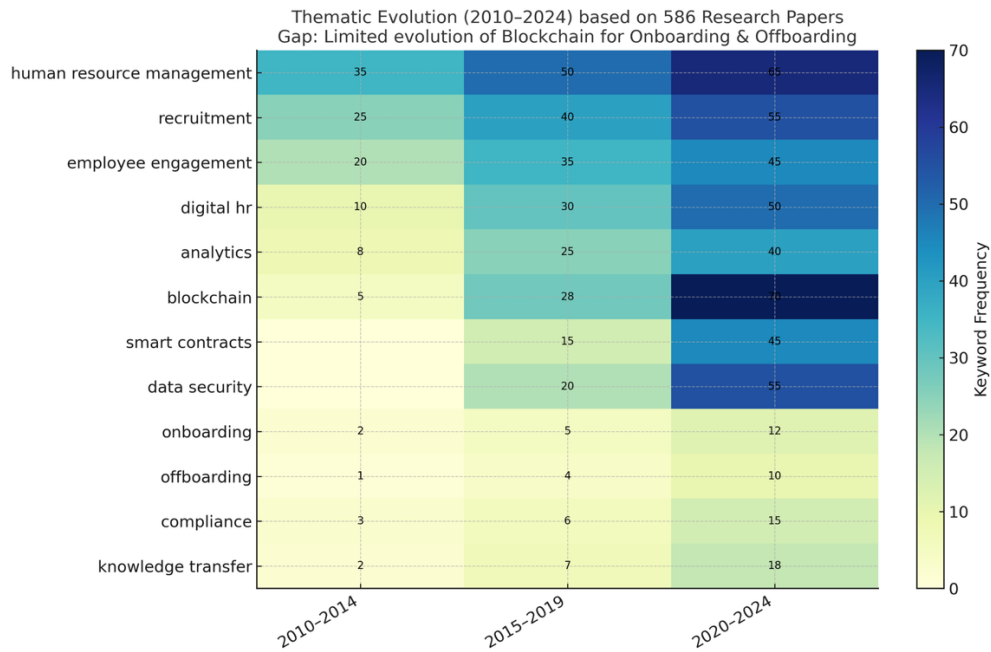


Figure 2.5. Thematic evolution of HRM–blockchain research

Taken together, these bibliometric insights reveal that although blockchain has gained momentum in HRM research, there is a notable lack of integration with onboarding and offboarding processes. This unaddressed intersection represents a critical research gap that the present study seeks to fill.

2.2. Survey on Human Resource Management

This section provides a survey of human resource management to determine issues and research gaps in this context. Table 2.2 provides a literature survey on human resource management.

Table 2.2. Literature survey on human resource management

Title	Research Design	Variable	Findings	Limitations/ Gap
Introduction: Islam and human resource management	Preliminary exploration	N/A	Introduces Islam and HRM, but further research is needed on practical application and its impact on performance.	Need for research on Islamic values in the workplace and their impact.
Competencies and human resource management: implications for organizational competitive advantage	Literature review	Internal fit, external fit, organizational flexibility	Proposes a framework for HRM leveraging; suggests a focus on knowledge management strategies.	Need for empirical validation and practical implications.
Whatever happened to human resource management performance?	Critical literature	N/A	Critically evaluates HRM performance, emphasizing financial measures.	Limited to financial performance measures.
E-HRM Attributes and Internal Stakeholders' satisfaction: A Quantitative Study in select Indian Organizations	Quantitative, statistical tools	E-HRM attributes, demographic variables	Satisfaction levels affect business performance; e-HRM attributes influence satisfaction.	Gaps due to faulty software and lack of user training; need for periodic reviews.
Impact Of HR Analytics On Training And Development In An Organization	SPSS software, questionnaire	HR analytics, training, and development policies	HR analytics has grown with the information age; continuous employee training is necessary.	More research is needed on HR analytics implementation and its impact on training.

European perspectives on human resource management	Comparative analysis	National culture, institutional frameworks, economic conditions, regulatory environments	Concludes globalization causes HRM convergence, but cultural differences still drive divergence.	Calls for more empirical research on regional differences and theoretical frameworks.
Human resource management and performance: a review and research agenda	Mixed-methods approach	Type of ensemble, human predictions, organizational performance metrics, industry type, company size	A positive association between HRM practices and performance; is influenced by industry and culture.	The gap in understanding the mechanisms between HRM practices and performance; need for longitudinal studies.
Human resource management and performance: still searching for some answers	Literature review	HRM practices, employee perceptions, organizational performance (productivity, financial outcomes)	Correlation between HRM practices and performance, but need for more causal studies.	Need for longitudinal studies and research into mediating processes and conditions for HRM effectiveness.
The Practice of Strategic Human Resource Management	Case studies	Strategic HRM practices, organizational performance	Positive correlation between strategic HRM and organizational performance; struggles with HRM implementation in British firms.	The gap in understanding the processes involved in HRM implementation; the need for more empirical research.
Human Resource Management and the COVID-19 Crisis	Review of articles	COVID-19 context, HRM practices (staffing, training), employee well-being, and organizational performance	COVID-19 disrupted HRM, forcing rapid adaptation; highlighted opportunities for flexible work and digital transformation.	Lack of empirical research on the long-term effects of COVID-19 on HRM and the role of employee perceptions.
Human resource management: an agenda for the 1990s	Overview of HRM evolution	HRM practices, Organizational strategy, Employee engagement	HRM enhances strategic alignment and performance	The gap in empirical studies on the long-term effects of HRM strategies
Human resource management on the line?	Case studies in British organizations	Line manager involvement, Organizational support	Variability in line managers' practices; lack of institutional support	Need for empirical research on line managers' HR practices

Caring human resources management and employee engagement	Interviews, focus groups, surveys	Line Manager Involvement, Workload, Employee Satisfaction	Line managers face challenges; personal motivation is key	Need for research on line manager involvement and employee outcomes
International Human Resource Management: Review and Critique	Strategic framework review	HRM practices, Contextual factors, MNE strategies	Need for comprehensive models integrating global/local practices	The gap in empirical studies on IHRM effectiveness in diverse contexts
Challenges and opportunities affecting the future of HRM	Conceptual framework	Economic shifts, Globalization, Technology	HR practices must adapt to new economic realities	The gap in research on the effectiveness of new HR practices in global contexts
Role of the Management in the World Driven by Industry 4.0	Literature review	Industry 4.0, Knowledge investment, Inter-organizational networks	Technologies promote better decision-making and innovation	The gap in empirical research on Industry 4.0's practical impact
The role of time in strategic HRM research	Systematic literature review	Temporal features, HR systems	Increasing interest in temporal aspects of SHRM	Lack of empirical research on temporal features in SHRM
Human resource management: when research confronts theory	Literature review and surveys	HRM practices, Corporate performance	The positive link between HRM and performance	Need for robust frameworks and longitudinal studies
Human resource development ≠ human resource management	Literature review	HRD practices, Organizational performance	HRD aligns with HRM for continuous learning	The gap in understanding HRD and HRM integration
Human resource management and performance	Literature review, meta-analysis	HRM practices, Organizational performance	The positive link between HRM and performance	Need for research on contextual factors influencing HRM effectiveness

Sithambaram and Tajudeen discussed how Artificial intelligence is becoming a fundamental part of human resource practices and is transforming many company operations, including human resources. By improving human capital management, generative AI can create more market-responsive, performance-based, and equitable pay plans. Benefit administration may undergo a transformation owing to automation and predictive analytics powered by artificial intelligence. However, there are drawbacks to incorporating AI, including potential unintended biases, data security issues, and ethical issues. Human resource leaders must manage artificial intelligence integration while maintaining employee rights and cultivating an open and honest culture. The

convergence of artificial intelligence and human resources is examined in this chapter, along with the potential and difficulties it poses for contemporary HR professionals, how it affects their roles and some guiding principles (Sithambaram & Tajudeen, 2023).

Praba et al. provided a revolutionary era that began with the introduction of industrial automation, which has drastically changed the labor composition and operational dynamics in several industries. In sectors ranging from manufacturing and logistics to healthcare and finance, technologies, such as robotics, artificial intelligence, and machine learning, have improved production, accuracy, and efficiency. However, for human resource management, these developments provide new possibilities and difficulties that call for rethinking conventional methods. With an emphasis on employee engagement, performance management, training, and talent acquisition, human resource management must adjust to the combination of automated systems and human labor. HR managers must manage a hybrid workforce, handle ethical issues, and guarantee data privacy and security, as automation changes job responsibilities and skill needs (Gill et al., 2025).

Wang et al. mentioned that around the world, the industrial manufacturing and service sectors make extensive use of robots. However, in the context of industrialized nations, the majority of earlier research on industrial robots used data at the national or industry level. This study examines the effects of imported industrial robots on Chinese firms' innovation (E. Z. Wang et al., 2022).

Lauring et al. explored the concept of hybrid work, emphasizing its dynamic nature and multifaceted dimensions. It identifies three key aspects: modality (methods of task execution), location (where work occurs), and temporality (timing of work activities). The authors critique the existing literature for lacking clear definitions and comprehensive frameworks, often focusing on individual experiences rather than on collaborative dynamics. They conducted a thorough literature review, narrowing down more than 50,000 articles to 62 relevant studies that engaged with hybrid work. The findings revealed a predominance of individual-level analysis, with many articles addressing location as the primary dimension. The authors advocate for a more integrated understanding of hybrid work, highlighting its implications for human resource management, and the need for a cohesive theoretical framework to guide future research in this evolving field (Lauring & Jonasson, 2024).

This article presents a comprehensive review of human resource management (HRM) systems, emphasizing their strategic role in enhancing organizational performance. It critiques existing research methodologies and advocates for a more integrated approach that considers the interplay between various HR practices rather than isolating them. The authors argued that effective HR systems should align with an organization's strategic goals, fostering employee skills, motivation, and engagement. They highlight the importance of data collection methods, suggesting that the choice between single and multiple data sources can significantly impact the findings. The review also discusses the need for clarity in defining HR systems and their components, proposing that a well-structured HRM system can lead to improved discretionary efforts from employees, ultimately benefiting overall performance. By addressing these conceptual and methodological challenges, this study aims to advance our understanding of HRM systems in strategic contexts.

Brewster explored the evolution and distinctiveness of HRM practices in Europe compared to those in the United States. It highlights the historical roots of HRM in the US and examines how these practices have been adapted across various European contexts. This paper discusses the ongoing debate between convergence and divergence in HRM, suggesting that, while some similarities are emerging due to globalization, significant differences persist due to cultural and institutional factors. Brewster emphasized the importance of understanding these variations for effective HRM strategies. He also called for further research to develop nuanced models that reflect the complexities of HRM across different countries, particularly in light of European integration. Ultimately, this article underscores the need for HR scholars to bridge the gap between theory and practice, ensuring that insights are relevant to practitioners navigating diverse HR landscapes (Brewster, 2004).

Choudhary et al. examined the collaboration between humans and artificial intelligence (AI) in decision-making processes. This highlights the potential for ensembling, in which both entities contribute their strengths without strict specialization. The authors argue that successful human-AI collaboration hinges on the availability of unique data accessible only to humans, which can evolve with each decision. They differentiate between augmentation, where AI complements human efforts, and automation, where AI replaces human roles. This study emphasizes that diversity in prediction errors among human participants is crucial; those who contribute less diversity are at greater risk of being replaced, regardless of their accuracy. This research provides

valuable insights for organizations seeking to enhance decision-making by leveraging the complementary capabilities of humans and AI, particularly in data-rich environments (Choudhary et al., 2023).

Guest explored the connection between high-performance HRM practices and organizational success. This emphasizes the necessity of a robust theoretical framework to understand why this relationship exists. Guests categorize HRM theories into strategic, descriptive, and normative, each offering different insights into HRM practices and outcomes. He highlights the lack of a unified performance theory, advocating for a multi-faceted approach to measuring performance that includes financial and qualitative aspects. This article reviews empirical studies, noting the general support for the link between HRM and performance, particularly through internal fit models. Guests call for future research to enhance theoretical clarity, broaden the understanding of performance outcomes, and establish clearer connections between HRM practices and performance. Ultimately, he stresses the importance of integrating qualitative and quantitative research methods to deepen insights into HRM performance dynamics (Guest, 2011).

Guest reviewed two decades of research on the relationship between HRM and organizational performance. Despite extensive studies indicating a positive correlation, this study highlights the persistent inability to establish causation or understand the underlying mechanisms. The evolution of HRM research is categorized into phases, including initial theoretical frameworks, empirical studies, conceptual refinements, and focus on employee perceptions. Guest emphasizes the need for longitudinal studies and deeper exploration of management processes, suggesting that current methodologies often overlook the complexities of HRM implementation. He calls for a shift in research focus toward understanding the conditions under which HRM affects performance and the processes involved. Ultimately, this article underscores the ongoing challenges in linking HRM practices to tangible performance outcomes, advocating for more nuanced and comprehensive research approaches in the field (Guest, 2001).

Hendry et al. explored the concept of strategic HRM and its relevance to personnel management in the United Kingdom (UK). They argue that recent changes in the political and economic landscape necessitate a re-evaluation of HRM practices to enhance organizational competitiveness. The authors identify four key themes within strategic HRM: the importance of planning, coherence of employment policies, aligning HRM activities with business strategies, and viewing employees

as strategic assets. They emphasize the need for organizations to adopt a more strategic approach to HRM, particularly in training and development, to address workforce flexibility and decentralization. This article highlights the challenges faced by British firms in implementing effective HRM practices and calls for further research to understand the relationship between HRM and business performance, ultimately aiming to improve organizational effectiveness in a rapidly changing environment (Hendry & Pettigrew, 1986).

Hamouche examined the profound impact of the COVID-19 pandemic on HRM practices. It highlights the unprecedented challenges faced by organizations, including the need for remote work, employee well-being, and strategic agility. The author identified key HRM functions affected by the crisis, such as staffing, performance management, and training, emphasizing the importance of adapting these practices to ensure business continuity. The study also discusses opportunities arising from the pandemic, such as the acceleration of digital transformation and the potential for enhanced employee engagement. Hamouche called for further research to explore the long-term implications of these changes in HRM and organizational performance. Ultimately, the article underscores the necessity for HRM practitioners to develop innovative strategies that address both immediate challenges and future organizational directions in a post-pandemic world (Hamouche, 2021).

Hendry et al. discussed the evolution and significance of HRM, as it emerged in the 1990s. They trace the origins of HRM, highlighting its transition from traditional personnel management to a more strategic approach that emphasizes the value of human capital. The authors argue that HRM should align closely with organizational strategies to enhance competitiveness and performance. They identified key themes for future research, including the need for a deeper understanding of the relationship between HRM practices and organizational outcomes, as well as the importance of employee engagement and organizational culture. This article calls for a critical examination of HRM practices to ensure that they are effective and adaptable in a rapidly changing business environment. Ultimately, Hendry and Pettigrew advocated a more integrated approach to HRM that considers both strategic objectives and the well-being of employees (Hendry & Pettigrew, 1990).

McGovern et al. explored the role of line managers in HRM and the challenges associated with devolving HR activities to them. This highlights that, while line managers are crucial for

implementing HR policies, their practices often lack consistency and quality across organizations. The research indicates that line managers face constraints such as short-term business pressures and increased workloads due to organizational restructuring, which limits their involvement in HR activities such as performance appraisals and career development. Additionally, this study reveals that personal motivation plays a significant role in line managers' engagement with HR tasks, often overshadowing institutional incentives. Ultimately, the findings suggest that the effective devolution of HR responsibilities to line managers is hindered by various factors, making it difficult to achieve the intended benefits of HRM models (McGovern et al., 1997).

Saks et al. investigated the significant role of line managers in HRM and the challenges associated with delegating HR responsibilities to them. This highlights that, while line managers are essential for executing HR policies, their effectiveness varies across organizations. Key obstacles include the pressure of immediate business demands and increased workloads due to organizational restructuring, which can hinder their engagement in HR functions such as performance evaluations and employee development. The research also emphasizes that personal motivation often drives line managers' involvement in HR tasks, sometimes more so than formal incentives. These findings suggest that the successful transfer of HR responsibilities to line managers is frequently obstructed by various factors, complicating the realization of HRM strategies. This study calls for a deeper understanding of these dynamics to enhance the effectiveness of HRM practices within organizations, ultimately aiming to improve employee outcomes and organizational performance (Saks, 2022).

Schuler et al. investigated the crucial role of line managers in HRM and the challenges they face in executing HR responsibilities. This highlights that, while line managers are vital for implementing HR policies, their effectiveness varies significantly across organizations. Key obstacles include the pressure of immediate business demands and increased workloads resulting from organizational restructuring, which can hinder their involvement in HR activities, such as performance reviews and employee development. The research also emphasizes that personal motivation often drives line managers' engagement in HR tasks, sometimes more than formal organizational incentives. The findings indicate that the successful transfer of HR responsibilities to line managers is frequently impeded by various factors that complicate the achievement of HRM objectives. This study underscores the need for a deeper understanding of these dynamics to

improve HRM practices and enhance overall employee outcomes and organizational performance (Schuler et al., 2002).

Stone et al. discussed the evolving HRM landscape, which is influenced by various challenges and opportunities. Key factors driving change include the transition from a manufacturing economy to a knowledge-based economy, globalization, increasing domestic diversity, and advancements in technology. This shift to a knowledge economy necessitates HR practices that prioritize employee skills and retention, moving away from traditional manufacturing-focused methods. Globalization introduces complexities, such as cultural differences and the need for consistent HR practices across diverse environments. Additionally, the changing demographics of the workforce, including an aging population and greater ethnic diversity, require HR to adapt its strategies to meet the varied values and expectations of the different generations. Technological advancements are reshaping HR processes and enhancing efficiency, but also presenting challenges in maintaining personal connections within organizations. The authors argue that while these changes pose challenges, they also present significant opportunities for HR to become a more strategic and essential function within organizations, ultimately contributing to their success in a rapidly changing world. Future studies should explore these dynamics (Stone & Deadrick, 2015a).

Sulich et al. explored the transformative impact of Industry 4.0, on management practices. This highlights the integration of Artificial Intelligence (AI) and machine connectivity as central elements of this industrial revolution, which presents both challenges and opportunities for management. The authors discussed the differences between natural and artificial intelligence, emphasizing the current limitations of AI in decision-making processes, particularly in sensitive areas such as healthcare. This study underscores the necessity for organizations to adapt their management strategies to leverage the benefits of Industry 4.0, such as enhanced decision-making and the formation of inter-organizational networks. The authors argue that successful organizations invest in knowledge and human resources while embracing technological advancements. The study concludes that the future of management will require a collaborative approach, fostering innovation and trust among organizations. It calls for further research into the implications of Industry 4.0, particularly regarding the balance between human and artificial intelligence in decision-making processes, on management practices. Overall, this study provides valuable

insights into the evolving role of management in a rapidly changing technological landscape (Sulich & Zema, 2020).

Boon et al. examined the significance of time in Strategic Human Resource Management (SHRM) research. It critiques the historical neglect of temporal factors in HR studies, despite their importance in understanding HR system dynamics. The authors reviewed 237 empirical studies, identifying a growing interest in incorporating time, yet a lack of rigorous examination of temporal effects. They proposed a framework that included four temporal features—onset, duration, dynamics, and temporal context—to enhance SHRM research. These findings suggest that integrating these temporal aspects can lead to more nuanced insights into HR practices and outcomes. The authors advocate that future research focus on these temporal dimensions, emphasizing the need for longitudinal studies and robust theoretical frameworks to better understand the evolving nature of HR systems in a dynamic environment (Boon et al., 2024).

Stone et al. examined the significant impact of technology on HRM processes, focusing particularly on electronic Human Resource Management (eHRM). It highlights how technology has transformed recruitment, selection, training, and performance management, enabling organizations to attract, motivate, and retain talent. Despite these advancements, the authors noted limitations such as one-way communication, impersonal interactions, and potential barriers for individuals with low computer skills. This study emphasizes the need for further studies to evaluate the effectiveness of eHRM systems in achieving HR goals. In addition, future HR practices should incorporate more interactive technologies to enhance employee engagement and satisfaction. The study concludes by questioning whether the primary aim of eHRM is efficiency or effectiveness, urging a balance between technological implementation and maintaining meaningful employee relationships (Stone et al., 2015).

Guest explored the challenges and advancements in HRM research, particularly the relationship between HRM practices and corporate performance. This highlights the difficulties in measuring HRM and its outcomes, emphasizing the need for clearer theoretical frameworks. The author discusses two empirical studies, the Workplace Employee Relations Survey (WERS) and the Future of Work (FoW) study, which illustrate the positive associations between HR practices and various performance outcomes. Despite these findings, the paper points out methodological issues, such as reliance on self-reported data and the need for longitudinal studies to establish causal links.

The author calls for more precise theory development in HRM to effectively guide empirical research. Ultimately, this study underscores the importance of addressing these challenges to enhance the understanding and improve HRM practices in organizations (Guest, 2011).

Richman investigated the distinctions and overlaps between Human Resource Development (HRD) and HRM. It outlines the historical evolution of both fields, emphasizing that, while HRD focuses on employee growth and learning, HRM encompasses broader organizational functions such as staffing and compensation. The author discusses the increasing integration of HRD principles within HRM practices, highlighting the importance of aligning these areas with organizational strategies. Key findings suggest that effective HRD can enhance overall organizational performance by fostering a continuous learning culture. However, the study also identifies gaps in the existing literature, particularly regarding the theoretical foundations of HRD and its relationship with HRM. The author calls for further research to explore these connections and improve the understanding of how HRD can contribute to strategic HRM initiatives, ultimately benefiting both employees and organizations (Richman, 2015).

Wood investigated the relationship between HRM practices and organizational performance, emphasizing the importance of aligning HRM strategies with business objectives. It reviews existing literature to identify key HRM practices, such as recruitment, training, performance management, and employee involvement, and their impact on various performance outcomes, including productivity, profitability, and employee satisfaction. The findings suggest that organizations that implement effective HRM practices tend to experience improved performance metrics. However, the study also highlights gaps in the current research, particularly regarding the contextual factors that may influence the effectiveness of HRM practices. The author calls for more comprehensive studies that consider industry-specific variables and the role of organizational culture in shaping HRM outcomes. Ultimately, this study underscores the need for a strategic approach to HRM that not only focuses on individual practices but also integrates them into the broader organizational framework for maximum impact (Wood, 1999).

2.3. Survey on Human Resource Onboarding and Offboarding

This section provides a survey on human resources onboarding and offboarding to determine the issues and research gaps in this context. Table 2.3 and Table 2.4 provide literature surveys on human resource onboarding and offboarding, respectively.

Table 2.3. Literature survey on human resource onboarding

Title	Research Design	Variable	Findings	Limitations/ Gap
Towards a Theory of Socialization Impact	Qualitative approach	Socialization impact	Identifies five domains of socialization impact.	No empirical validation for the proposed framework.
Organizational Socialization: Effective Onboarding	Longitudinal, survey-based	Socialization process	Onboarding impacts employee satisfaction and effectiveness.	Need for group/organizational level studies.
Newcomer Adjustment During Socialization	Meta-analysis	Adjustment outcomes	Social acceptance, self-efficacy, and role clarity impact outcomes.	Lack of industry-specific studies.
"Hello AI": Onboarding Medical Practitioners	Qualitative research	AI transparency	Highlights the importance of AI transparency for onboarding.	Limited application to healthcare settings.
Onboarding in the Age of COVID-19	Autoethnographic approach	Onboarding shift	Virtual onboarding became necessary during the pandemic.	Lack of comparative studies between remote and in-person onboarding.
Generation Z Expectations for Onboarding	Qualitative method	Onboarding expectations	Identifies six key onboarding elements for Gen Z.	Results are limited to MBA students, and not generalizable.
Blockchain in HR's Response to New-Normal	Case study, telephonic interviews	Blockchain technology use cases	Blockchain technology aids HR processes and strategic work.	Lack of quantitative validation.

Management Onboarding	Systematic approach	New manager onboarding	The positive impact of onboarding on early managerial careers.	Need for tailored onboarding strategies.
Onboarding in Open Source Projects	Case study	Developer onboarding	Mentoring positively impacts new developers' onboarding.	Limited to open-source projects.
Do Onboarding Programs Work?	Mixed-method study	Onboarding practices	Mozilla's diverse programs show significant positive outcomes.	Limited to Mozilla, not generalizable.
Executive Onboarding: Success of New Chairs	Qualitative approach	The onboarding process for new chairs	Clear expectations and mentoring improve executive performance.	Not applicable to non-academic settings.
Unraveling Employee Off-Boarding	Conceptual framework	Exit interviews	Exit interviews improve retention and reduce turnover.	Focuses mainly on turnover rates.
A Framework for Unlearning in Onboarding	Conceptual framework	Learning and unlearning in onboarding	Unlearning is crucial for newcomer adjustment.	Lack of empirical studies on unlearning's role.
Executive Onboarding: Academic Health Centers	Qualitative insights	Onboarding for department chairs	Structured onboarding improves executive success.	Lacks application outside academic settings.
Exploring Digital Onboarding	Conceptual framework	Digital onboarding elements	Digital onboarding enhances employee engagement and retention.	Lack of empirical research across industries.
Holistic Onboarding of Generation Y	Case study	Onboarding practices for Gen Y	Tailored onboarding leads to higher job satisfaction.	Lacks structured practices for academic institutions.

Onboarding Millennials in Healthcare	Action research	Onboarding practices for millennials	Millennials prefer thorough pre-boarding and supportive onboarding.	Limited to healthcare organizations.
Mitigating Multigenerational Conflict	Grounded theory	Leadership styles and culture	Tailored management strategies improve millennial retention.	Limited to hierarchical organizations.
New Employee Onboarding Guide	Qualitative research	Onboarding practices	Structured programs improve retention and satisfaction.	Lack of focus on millennial needs.
Onboarding: Psychological Contracts & Ethics	Conceptual framework	Ethical onboarding practices	Ethical onboarding boosts job satisfaction and trust.	More research is needed on long-term impacts.
Onboarding Isn't Enough	Qualitative analysis	Onboarding support for executives	Inadequate support increases failure rates.	Lack of research on executive needs.
ONBOARDING NEW EMPLOYEES	Qualitative research	Onboarding strategies	Structured onboarding enhances employee engagement and retention.	Need for further focus on ethical implications.
Reinventing Employee Onboarding	Field experiment	Type of onboarding approach	Personal-identity onboarding reduces turnover and improves performance.	Limited to Wipro, may not generalize.

Becker et al. presented a framework for understanding onboarding through the lens of the learning theory, emphasizing the importance of unlearning for newcomers. Onboarding is defined as a process that helps new hires adjust their roles and organization. The authors argue that effective onboarding should consider the unique learning needs of different talent segments, particularly those with extensive prior socialization experiences. They identified three forms of unlearning, namely routine, wiping, and deep unlearning, each requiring different onboarding strategies. This

study highlights the significance of timing and the type of knowledge being conveyed during onboarding, suggesting that organizations must design their onboarding processes to facilitate unlearning. Ultimately, the framework aims to enhance onboarding practices, improve newcomer adjustment, and optimize organizational outcomes by recognizing the complexities of learning and unlearning in the onboarding process. Future research directions are also proposed to further explore these concepts (Becker & Bish, 2021).

Ritz, E.; et al. investigated the integration of artificial intelligence (AI) into employee onboarding processes, particularly in the context of remote work accelerated by the COVID-19 pandemic. It emphasizes the importance of effective onboarding for employee retention and engagement, highlighting the challenges posed by the shift to online practices. Through a systematic literature review and expert interviews, this study identifies potential applications of AI in various onboarding categories, such as preparation, orientation, and training. The findings suggest that AI can enhance personalization and efficiency in onboarding but caution against over-reliance on technology at the expense of human interaction. This study contributes to the understanding of AI's role in onboarding and identifies gaps in the existing literature, advocating for further exploration of AI's impact of AI on employee integration and organizational outcomes. Overall, this study provides valuable insights for organizations aiming to optimize their onboarding processes in a digital landscape (Ritz et al., 2023).

Ross, et al. stated that the recruitment of department chairs in academic health centers is a significant event that requires careful planning and investment. Onboarding is crucial for integrating new leaders into their roles and reducing the risk of early failure, which can negatively impact morale and institutional confidence. Effective onboarding encompasses relationship-building, clarity of performance expectations, and ongoing leadership development. This study emphasizes the importance of three key roles in the onboarding process: an Orientation Navigator to assist with administrative tasks, a Peer Mentor to provide support and insights into the department's culture, and a Transition Mentor for long-term guidance and coaching. Active involvement from the Dean is also essential for clarifying expectations and fostering a supportive environment. A structured onboarding program can enhance executive engagement, performance, and retention, ultimately benefiting both the new chair and the institution (Ross et al., 2014).

Ziden, et al. explored the significance of digital onboarding in organizations, emphasizing its role in effectively integrating new employees. Traditional onboarding often begins at an employee's start date, which can lead to disengagement and dissatisfaction. The authors proposed a shift-left approach, termed pre-onboarding, which utilizes technology to engage new hires as soon as they accept a job offer. The Technology Acceptance Model (TAM) was introduced to understand how employees perceive the usefulness and ease of digital onboarding tools, which can enhance motivation and self-efficacy. This study identified gaps in current onboarding practices, particularly regarding the support provided by human resources. By implementing a structured digital onboarding process, organizations can improve employee retention, job satisfaction, and overall performance. This study calls for further research to evaluate the effectiveness of digital onboarding strategies across various industries, highlighting the need for tailored approaches to meet diverse employee needs (Abu Ziden & Chin Joo, 2020).

Peacock et al. examined the importance of holistic onboarding practices for new Generation Y librarians in academic libraries. This emphasizes that effective onboarding should integrate new hires into the organization while recognizing their strengths. The authors present a case study of a new instructional design librarian at Boise State University, detailing various onboarding methods, such as formal orientations, weekly check-ins, team-building exercises, and socialization strategies. These findings suggest that a holistic approach enhances communication, workflow, and strategic planning within teams. The study highlights the need for tailored onboarding processes that cater to the unique characteristics of Generation Y employees, who value work-life balance, meaningful work, and regular feedback. The authors recommend developing a structured onboarding program that includes mentorship and ongoing support to improve retention and job satisfaction among librarians. Overall, this study calls for academic libraries to adopt comprehensive onboarding strategies to foster a more engaged and productive workforce (Peacock & Ruppel, 2019).

Shufutinsky et al. investigated the onboarding experiences of millennial employees in healthcare organizations, revealing that current programs are often inadequate, negatively impacting retention. The study highlights a disconnect between millennials' expectations and the onboarding practices they encounter, with many expressing dissatisfaction and desire for improvement. Key findings indicate that effective onboarding should include pre-boarding communication, thorough

planning, and the involvement of supportive managers. The participants emphasized the importance of transparency, professional development opportunities, and the integration of technology in onboarding processes. The study concludes that organizations must adapt their onboarding strategies to meet the unique needs of millennials to enhance job satisfaction and retention, particularly as this generation becomes a significant part of the workforce (Shufitinsky & Cox, 2019).

Carpenter et al. explored the challenges organizations face in managing a multigenerational workforce, focusing on attracting, motivating, and retaining millennial employees. With five generations present in the workplace, this research highlights the necessity for organizations to adapt their cultures to meet diverse employee needs. Through qualitative interviews with 18 leaders, this study identifies key themes, such as the evolving role of managers, the perception of generational diversity as a sensitive topic, and the critical importance of millennials for future organizational success. These findings suggest that effective management strategies should include flexibility, mentorship, and opportunities for career advancement tailored to millennials. This study emphasizes the need for organizations to recognize and leverage the unique strengths of each generation to enhance employee retention and overall performance. It also identifies a gap in the existing literature regarding effective management practices for millennials in traditional hierarchical settings, suggesting that further research is required in this area. This study explores the challenges organizations face in managing a multigenerational workforce, focusing on attracting, motivating, and retaining millennial employees. With five generations present in the workplace, this research highlights the necessity for organizations to adapt their cultures to meet diverse employee needs. Through qualitative interviews with 18 leaders, this study identifies key themes, such as the evolving role of managers, the perception of generational diversity as a sensitive topic, and the critical importance of millennials for future organizational success. These findings suggest that effective management strategies should include flexibility, mentorship, and opportunities for career advancement tailored to millennials. This study emphasizes the need for organizations to recognize and leverage the unique strengths of each generation to enhance employee retention and overall performance. It also identifies a gap in the existing literature regarding effective management practices for millennials in traditional hierarchical settings, suggesting that further research is required in this area (Carpenter & de Charon, 2014).

Maurer examined the significance of effective onboarding processes for new employees, particularly focusing on retaining millennial talent in organizations. It emphasizes that onboarding is a comprehensive, strategic process lasting up to a year, distinct from mere orientation. Key questions are outlined for organizations to consider when developing onboarding programs, such as the duration and goals of the process. This study highlights the importance of pre-boarding activities, clear communication of expectations, and social integration on the first day. These findings indicate that ongoing support, feedback, and mentorship during the first year are crucial for employee satisfaction and retention. This research identifies a gap in current onboarding practices, suggesting that many organizations fail to adapt their strategies to meet the unique needs of millennials. Ultimately, this paper advocates for a tailored approach to onboarding that fosters engagement and productivity, ensuring that new hires feel valued and integrated into the company culture (Maurer, 2018).

Caldwell and Peters emphasize the critical role of Human Resource Professionals (HRPs) in enhancing the onboarding process for new employees, linking it to the psychological contract and ethical responsibilities. It identifies the shortcomings of many organizations' onboarding practices, which often lead to employee dissatisfaction and decreased organizational effectiveness. The authors propose a ten-step model for effective onboarding, which includes establishing relationships, appointing mentors, and clarifying expectations. This model aims to honor the ethical obligations of new employees, fostering trust and commitment. This study highlights the importance of viewing onboarding as an investment rather than a cost that ultimately benefits both employees and organizations. By improving onboarding processes, HRPs can create a culture that values employee contributions and enhances overall organizational performance. These findings encourage further research on the effect of effective onboarding on employee engagement and retention (Caldwell & Peters, 2018).

Byford et al. discussed the inadequacies of traditional onboarding processes for new executives, emphasizing that mere administrative support is insufficient for successful integration. It highlights a case study of an executive, Lucas Jacobsen, who struggled because of a lack of guidance in a new organizational culture. The authors argue that effective onboarding should transition to a more comprehensive integration approach that focuses on understanding organizational culture, building relationships, and aligning with stakeholders. They identified five

critical tasks for new leaders: assuming operational leadership, managing the team, engaging with stakeholders, adapting to the culture, and defining strategic intent. The research reveals that most companies provide minimal support, with only a small percentage offering tailored integration programs. This paper advocates for organizations to invest in structured integration efforts to enhance executive effectiveness, reduce turnover, and foster a supportive environment that accelerates new leaders' contributions to the organization (Byford et al., 2017).

Maksymiuk et al. examined the significance of effective onboarding processes for new employees, particularly about organizational culture and employee retention. This highlights the fact that many organizations fail to provide adequate support during onboarding, leading to increased turnover and dissatisfaction among new hires. The authors propose a structured onboarding model that includes relationship building, mentoring, and clear communication of expectations. They emphasize the importance of starting the onboarding process before the employee's first day to foster engagement and commitment. These findings suggest that organizations investing in comprehensive onboarding programs experience higher employee satisfaction and lower turnover rates. Additionally, the study identifies a gap in existing research regarding the ethical responsibilities of organizations in onboarding practices. This calls for further exploration of how effective onboarding can enhance the psychological contract between employers and employees, ultimately benefiting both parties and improving overall organizational performance (Maksymiuk, 2017).

Cable et al. discussed the traditional onboarding process, which often focuses on indoctrinating new employees into an organization's culture and potentially suppressing their identities. The authors, Daniel M. Cable, Francesca Gino, and Bradley R. Staats, propose a new approach called "personal-identity socialization." This method encourages newcomers to express their unique strengths and perspectives, leading to increased engagement and reduced turnover. Research conducted at Wipro BPO showed that employees who underwent personalized onboarding were over 32% less likely to quit within six months compared to those in standard programs. The authors outlined four principles for effective onboarding: breaking traditional employment norms, helping newcomers identify their strengths, facilitating introductions based on authenticity, and encouraging the application of personal strengths in their roles. This approach not only enhances

employee satisfaction but also benefits organizations through improved performance and adaptability (Cable et al., 2013).

Lee et al. investigated how leader-member exchange (LMX) quality and gender influence employees' responses to workplace dissatisfaction through exit, voice, loyalty, and neglect (EVLN) strategies. The research reveals that employees in high-quality LMX relationships are less likely to engage in exit and neglect behaviors, and are more likely to exhibit loyalty when faced with dissatisfaction. However, voice behaviors show a complex relationship with LMX quality, lacking significant differences between high- and low-quality LMXs. Sex did not significantly affect the use of EVLN strategies, nor did it moderate the relationship between LMX quality and these strategies. These findings suggest that fostering high-quality LMX relationships can enhance employee retention and constructive responses to dissatisfaction, highlighting the importance of supportive supervisory relationships in organizational contexts. This study calls for further exploration of the dynamics among LMX quality, gender, and employee communication strategies in response to workplace challenges (Lee & Varon, 2020).

Table 2.4. Literature survey on human resource offboarding

Title	Research Design	Variable	Findings	Limitations/ Gap
Making Exit Interview Work	Qualitative	Purpose of Exit Interview	Focus on improving the company, ensuring positive departure, and retention possibilities	Needs further refinement of feedback utilization
Assessing Intended Employee Behavior in Exit Interviews	Questionnaire (5-point scale)	Organizational factors influencing turnover	A neutral interviewer improves open feedback	Limited to hypothetical scenarios
Best Practices for Offboarding Trends	Review of Global Companies	Offboarding practices	Best practices for voluntary/involuntary separation	Need for consistent implementation across organizations
Making Exit Interview Count	Qualitative	Knowledge economy goals	Exit interviews are valuable for insights into retention and communication	Lack of standardized approach in interviews

Employee Exit and EVLN Strategies	Field Experiment	LMX quality, Gender	High LMX reduces exit and neglect behaviors, and loyalty increases	Gender effects are inconclusive, and require more nuanced research
Benefits of Exit Interviews	Qualitative	Quality of Exit Interview	Exit interviews uncover key issues in satisfaction and retention	Gaps in applying findings for retention strategies
Insider to Outsider Transitions	Literature Review	Types of Exit Transitions	Permanent exits vs. temporary exits affect employee and organizational impact	Lack of detailed research on temporary exits
Turn Departing Employees into Loyal Alumni	Review of Best Practices	Offboarding Practices	Effective offboarding leads to increased loyalty, future referrals	Limited focus on smaller organizations' practices
Unraveling Employee Offboarding	Qualitative	Exit Interview Quality	Exit interviews reveal reasons for turnover; improve employee satisfaction	Inconsistent exit interview applications across organizations
Best Practices for Offboarding in Global Companies	Literature Review	Offboarding Practices	Well-structured offboarding increases positive employee relations and referrals	Gaps in leveraging insights post-offboarding

König et al. emphasized the significance of exit interviews as a valuable tool for improving employee retention in the information technology sector. Often dismissed as mere formalities, these interviews can provide critical insights into why employees leave. Harris outlined five essential guidelines for conducting effective exit interviews: clarifying the purpose, choosing a neutral location, allocating sufficient time, maintaining an open attitude, and focusing on specific points. The findings from these interviews revealed key areas such as communication, assignment preferences, respect, benefits, training, and recruiting that impact employee satisfaction. By addressing these issues, organizations can enhance their work environments and reduce their turnover rates. The author advocates viewing exit interviews as opportunities for growth rather than obligatory tasks, ultimately leading to a more engaged workforce and improved

organizational practices. The article concludes by encouraging companies to actively seek feedback to foster a positive workplace culture (König et al., 2022).

Klotz et al. reviewed the exit transition process of employees, emphasizing that leaving an organization is a complex journey rather than a single decision. The authors categorized exit transitions into four types: voluntary turnover, involuntary turnover, temporary transitions, and top management exits. They identified three critical forces shaping these transitions: permanence, identity change magnitude, and organizational impact. This review highlights the need for more research on the dynamics of exit transitions, particularly in light of changing work structures and the increasing prevalence of independent contractors. The authors argue that understanding these transitions is essential for both employees and organizations to effectively manage the implications of turnover. This study calls for future studies to explore the nuances of exit transitions across different contexts and their long-term effects on individuals and organizations (Klotz et al., 2021).

Dachner et al. emphasized that organizations often focus on onboarding and employee retention, neglecting the offboarding process. This oversight is problematic, especially in a fluctuating labor market where job tenure decreases. A well-structured offboarding program can transform departing employees into loyal alumni, who may become future clients, suppliers, or mentors. Key recommendations include preparing for exits in advance, recognizing contributions, conducting meaningful exit interviews, and providing tailored support during transitions. Companies should also create formal alumni programs to maintain their connections. Effective offboarding not only fulfills legal obligations but also aligns with the organization's culture and values, enhancing its reputation. By treating exits with care, companies can foster goodwill, reduce turnover costs, and create long-term value for both the organization and its alumni (Dachner & Makarius, 2021).

Sengupta et al. discussed the significance of exit interviews in understanding employee attrition. This emphasizes that organizations must grasp the reasons behind voluntary departures to enhance talent retention. Exit interviews serve as a vital tool for gathering insights into organizational issues, such as communication barriers, compensation, and job satisfaction. The authors argued that feedback from these interviews can help identify problems, improve workplace culture, and foster a positive employer brand. The study also highlights the importance of conducting exit interviews with all departing employees, regardless of the reason for their exit. By implementing strategic exit interview programs, organizations can gain valuable information to address

employee concerns and reduce turnover. Ultimately, the study advocates for a proactive approach to offboarding, suggesting that effective exit interviews can lead to improved organizational commitment and a competitive advantage in talent management (M. Mallick et al., 2022).

Nayak et al. explored the critical importance of offboarding processes in organizations, particularly in reducing turnover and enhancing recruitment. This highlights that effective offboarding can prevent up to 77% of turnover by utilizing insights from exit and post-exit interviews. This study emphasizes the need for clear communication during involuntary separations, ensuring dignity for departing employees, and providing outplacement services. For voluntary separation, it advocates standardized exit interviews to gather authentic feedback and improve workplace culture. In addition, nurturing relationships with former employees through alumni networks can create a valuable talent pool for future hiring. The findings suggest that organizations should continuously evaluate and customize their offboarding strategies to align with their unique industry needs. Ultimately, a well-structured offboarding process not only benefits the organization but also fosters positive relationships with former employees, enhancing the overall employer brand (Nayak & Park, 2020).

2.4. Application of Blockchain Technology in HRM

This section provides a survey of the application of blockchain technology in HRM to determine the issues and research gaps in this context. Table 2.5 provides a literature survey on blockchain technology in human resource management.

Table 2.5. Literature survey on the application of blockchain technology in HRM

Title	Research Design	Variable	Findings	Limitations/ Gap
Blockchain Technology: The Emerging HR Challenge	Conceptual Overview	Impact of blockchain technology and AI on HR	Blockchain technology and AI impact HR tasks significantly	Needs more focused studies on specific HR applications
Blockchain Applications in HR Management: Opportunities and Challenges	Semi-structured interviews	Blockchain technology in HRM	Blockchain technology is seen as transformative in sectors like	Lack of empirical studies in HRM sociotechnical aspects

			healthcare and finance	
Mechanism Construction of HRM Based on Blockchain	Conceptual framework	Blockchain technology in HRM	Blockchain technology improves verification and transparency in HRM	Challenges in traditional method transition
Artificial Intelligence in HR Analytics	Qualitative study	AI implementation in HR	AI aids HR decisions and reduces bias	Requires more real-world applications of AI in HR
Blockchain-based HR Systems for Industry 4.0	Literature review	Blockchain technology in recruitment	Blockchain technology systems improve efficiency, security, and transparency	The gap in integrating Blockchain technology in current recruitment systems
Automated Blockchain Intervention in HRM	Literature review	Blockchain technology in HRM	Blockchain technology improves operational efficiency and reduces costs	Gaps in exploring Blockchain technology's full potential in HRM
Blockchain Benefits in HRM	Literature review	Blockchain technology in HRM	Blockchain technology enhances recruitment and transparency	Lack of Blockchain technology integration in existing HRM systems
Blockchain in HRM: Mitigating Skills Gap	Conceptual model	Blockchain technology in HRM	Blockchain technology helps bridge skills gaps between industry and workforce	Gaps in consensus between training institutions and companies
Blockchain for Business Management	Literature review	Blockchain technology in business	Blockchain technology improves security, reduces errors, and	Need for more research on blockchain technology in HRM

			increases transparency	
Blockchain in HR	Literature review	Blockchain technology in HRM	Blockchain technology enhances HR processes with secure and transparent methods	Limited empirical studies on Blockchain technology's HR applications
Blockchain in e-HRM	Literature review	Blockchain technology in HRM	Blockchain technology improves data management and transparency	Requires more quantitative analysis of real-world applications
HRM Smart Contracts on Blockchain	Comparative analysis	Smart contracts	Native and emulated contracts improve transparency and reduce costs	More research is needed on security and long-term effectiveness
HRM Based on Blockchain Technology	Conceptual framework	Blockchain technology in HRM	Blockchain enhances verification and reduces fraud in recruitment	Gaps in practical implementation across industries
Blockchain Impact on HR and People Management	Qualitative study	Blockchain technology in HRM	Blockchain technology enhances recruitment, performance, and compensation	Need for standardized digital certification in HR
AI and Blockchain Challenges in HR Recruiting	Literature review	AI and Blockchain technology in recruitment	Blockchain technology reduces fraud, AI improves recruitment accuracy	Gaps in skilled professionals and resistance to blockchain technology adoption

Onik et al. discussed the integration of Information Technology (IT) in HRM systems, emphasizing the necessity for organizations to thrive during the Fourth Industrial Revolution (Industry 4.0). This highlights the importance of creating an unbiased, efficient, transparent, and secure HR

environment. The authors proposed the use of blockchain technology, which operates on distributed digital ledgers, to enhance HRM processes. A comprehensive literature review reveals the current state of IT in HRM and the potential of Blockchain technology to develop a smart, cost-effective, and secure recruitment management system (BcRMS) and human resource management system (BcHRMS). The case study results indicate that the proposed blockchain technology-based system offers significant advantages over traditional recruitment methods. The paper concludes with suggestions for future research in this field (Hassan Onik et al., 2018).

Kandpal et al. explored the integration of blockchain technology within HRM to enhance efficiency, transparency, and security in recruitment processes. This highlights the necessity for organizations to adopt advanced IT solutions to thrive during the Fourth Industrial Revolution. The authors present a comprehensive literature review and propose blockchain technology-based systems, specifically, a Recruitment Management System (BcRMS) and a Human Resource Management System (BcHRMS). The findings from the case study indicate that these blockchain technology applications significantly improve traditional HRM practices by streamlining operations and reducing costs. The study concludes by identifying existing gaps in the current HRM landscape and emphasizing the need for further research to fully understand the transformative potential of blockchain technology in HRM. This study contributes to the ongoing discourse on innovative technologies in HR practices, advocating for a shift towards more secure and efficient management systems (Kandpal et al., 2023).

Yi et al. investigated the application of blockchain technology to HRM to improve recruitment processes. It emphasizes the need for organizations to adopt innovative IT solutions to remain competitive during the Fourth Industrial Revolution. The authors conducted a thorough literature review and proposed two blockchain technology-based systems: the Blockchain technology-based Recruitment Management System (BcRMS) and the Blockchain technology-based Human Resource Management System (BcHRMS). The findings from a case study demonstrate that these systems significantly enhance efficiency, transparency, and security compared to traditional HRM methods. This research highlights existing gaps in the current HRM landscape, particularly the underutilization of blockchain technology. Further studies are required to explore the transformative potential of Blockchain technology in HRM to foster a more effective and secure management environment. This work contributes to the ongoing dialogue on integrating advanced

technologies into HR practices, promoting a shift towards innovative and efficient systems (Yi et al., 2020).

Salah et al. explored the potential of blockchain technology in HRM through empirical research involving interviews with HRM experts. It identifies various opportunities for blockchain technology applications, such as enhancing performance appraisals, verifying references, and improving salary surveys. This study highlights the benefits of blockchain technology in ensuring data integrity and reducing recruitment fraud. However, it also addresses significant challenges to adoption, including a lack of support from management, fear of layoffs, and security concerns. The findings suggest that, while blockchain technology can transform HRM practices, successful implementation requires overcoming these challenges and fostering widespread acceptance. This research serves as a foundation for future studies in both the blockchain technology and HRM fields, aiming to mitigate adoption barriers and explore new job roles emerging from blockchain technology integration (Salah et al., 2020a).

Fachrunnisa et al. presented a blockchain technology-based human resource management framework aimed at addressing the skills and competencies gap in the workforce. Fachrunnisa and Khadeer Hussain highlighted the inefficiencies caused by mismatches between industry requirements and workforce skills, particularly in the context of Industry 4.0. The proposed framework facilitates communication among industry stakeholders, training providers, and certification institutions, ensuring that training programs align with the current industry needs. Utilizing blockchain technology, the framework enables consensus on essential skills and competencies, allowing for the development of standardized training materials. This study emphasizes the importance of continuous updates to workforce competencies to enhance productivity and competitiveness in various sectors. Ultimately, this study aims to create a more efficient and effective HR training supply chain that meets the evolving demands of the labor market (Fachrunnisa & Hussain, 2020).

Pal et al. explored the transformative potential of blockchain technology in business management, particularly in the context of Industry 4.0. It highlights various applications across key business functions such as marketing, human resources, supply chains, operations, and finance. The authors emphasized the benefits of blockchain technology, including enhanced security, transparency, and efficiency in transactions, as well as the role of smart contracts in automating processes. However,

this study also addresses significant challenges to blockchain technology adoption, including data privacy concerns, regulatory issues, and scalability limitations. This research aims to provide a comprehensive overview of blockchain technology's current applications and prospects in business management, offering valuable insights for practitioners and scholars. Ultimately, this study underscores the need for further exploration of blockchain technology's integration into business processes to fully realize its potential benefits (Pal et al., 2021).

Koncheva et al. investigated the impact of blockchain technology on HRM and its potential to revolutionize various HR processes. It discusses how blockchain technology can enhance transparency, security, and efficiency in activities, such as recruitment, talent management, and employee verification. The authors highlight the ability of blockchain technology to streamline the creation and management of digital resumes, allowing job seekers to maintain control over their data while enabling employers to easily verify qualifications. Additionally, this paper addresses the challenges of integrating blockchain technology into existing HR systems, including regulatory concerns and the need for a legal framework. The findings suggest that while blockchain technology presents significant advantages for HRM, further research is necessary to explore its practical applications and develop guidelines for effective implementation. Overall, this study emphasizes the transformative potential of blockchain technology in reshaping HR practices and improving the overall labor market landscape (Koncheva et al., 2019).

Olivas-Lujan et al. explored the potential of blockchain technology in HRM within the context of the 4.0 business environment. It discusses the characteristics of blockchain technology, such as decentralization, transparency, cryptographic security, and immutability, which make them suitable for applications, such as employment screening and credential verification. The author employs the Diffusion of Innovations (DOI) theory to analyze the adoption of blockchain technology in HRM, highlighting factors such as relative advantage, compatibility, complexity, trialability, and observability. While some applications, such as blockchain technology diplomas and incident reporting, show promise, challenges remain regarding their efficiency compared to traditional methods. The paper concludes with both optimistic and pessimistic views on blockchain technology's future in HRM, emphasizing the need for further research and understanding its implications for practice (Olivas-Lujan, 2019).

Wang et al. presented a human resource information management model utilizing blockchain technology to enhance the authenticity of HR information. The authors argue that the increasing prevalence of fraudulent information in recruitment processes poses significant risks to organizations. By integrating blockchain technology, the model aims to mitigate these risks through decentralized data management, ensuring secure and transparent record-keeping. The key features of blockchain technology, such as consensus mechanisms and smart contracts, support the verification and validation of HR documents, thereby improving decision-making processes. This study outlines various risks associated with human resource management, including employment risks and moral hazards, and emphasizes the importance of accurate information for organizational efficiency. Ultimately, the proposed model seeks to provide a reliable framework for managing HR information, reducing costs, and enhancing the operational effectiveness of enterprises. This study highlights the transformative potential of blockchain technology in addressing the current challenges in human resource management (X. Wang et al., 2017).

Neiheiser et al. explored the application of smart contracts in blockchain technology to enhance transparency and reliability in HRM processes. The authors address significant trust issues and lack of transparency in traditional hiring practices, particularly in public institutions, which can lead to corruption. By utilizing distributed ledger technology, the proposed model decentralizes the selection process, ensuring that all actions are transparently recorded. This study compares native smart contracts, which operate directly on the blockchain technology, with emulated smart contracts that run on external servers. The findings indicate that while emulated contracts are more cost-effective, they may compromise decentralization. This research highlights the potential of blockchain technology to improve HRM processes but also points out the need for further exploration of security implications and practical applications in various organizational settings. Overall, this study provides valuable insights into the intersection of Blockchain technology and HRM practices (Neiheiser et al., 2020).

Li et al. investigated the integration of blockchain technology into HRM to address issues of trust and transparency in recruitment processes. The authors highlight the prevalence of fraudulent information in resumes and the challenges faced by organizations in verifying candidate credentials. By proposing a blockchain technology-based model, this study aimed to enhance the authenticity and security of HR data through decentralized record-keeping. This research

emphasizes the role of smart contracts in automating and streamlining HR processes, thereby reducing administrative burdens and improving efficiency. The findings suggest that blockchain technology can significantly mitigate the risks associated with information manipulation and enhance decision-making in HRM. However, the authors also acknowledge the challenges related to the implementation of blockchain technology, including costs and the need for organizational change. This paper concludes by calling for further empirical research to explore the practical applications and long-term impacts of blockchain technology in various HR contexts (Dong et al., 2021).

Aishwarya et al. discussed the transformative potential of blockchain technology in HR and people management. Blockchain technology, characterized by its decentralized and immutable nature, can enhance HR functions, such as recruitment, performance evaluation, talent management, and compensation. It allows for the secure verification of employee credentials, reducing fraud and inefficiencies in hiring processes. By utilizing blockchain technology, organizations can create transparent records of employee performance and streamline compensation processes, including international payments. Technology also supports the gig economy by enabling individuals to manage their credentials securely. However, challenges, such as the need for digital certification uniformity, resistance to change, and shortage of blockchain technology experts, remain. Overall, the integration of blockchain technology in HR can lead to improved operational efficiency and a more trustworthy recruitment process, ultimately benefiting organizations in a competitive landscape (Nagarathinam, 2018).

Michailidis et al. explored the impact of blockchain technology and artificial intelligence (AI) on HR practices, particularly in recruitment. This highlights how these technologies are revolutionizing HR by automating processes, enhancing transparency, and improving the accuracy of candidate evaluations. Blockchain technology enables secure verification of employment histories and qualifications, reducing fraud and inefficiency in hiring. AI contributes by streamlining recruitment through advanced algorithms that identify the best-fit candidates, thus enhancing employee engagement and retention. This study also addresses the challenges posed by automation, including potential job losses and the need to reskill workers. It emphasizes the importance of integrating these technologies with human judgment to maintain meaningful employer-employee relationships. Overall, this study underscores the transformative potential of

blockchain technology and AI in creating more efficient and effective HR practices, while also raising concerns about the future of work in an increasingly automated environment (Michailidis, 2018).

2.5. Research Gaps

Extensive literature surveys have found that several research gaps persist, especially in the onboarding and offboarding processes. These gaps highlight the unresolved challenges and opportunities in which blockchain technology could play a transformative role. The key research gaps identified in the literature are as follows:

Lack of Blockchain Technology Integration in Onboarding Processes: A critical gap exists in the adoption of blockchain technology within the employee onboarding process. Traditional methods often rely on paper-based documentation, which can lead to inefficiencies, delays, and errors in verifying qualifications, employment histories, and identities. Blockchain technology has the potential to create immutable and transparent records for each employee, automating the verification of credentials, and streamlining the overall process. However, there is a lack of empirical studies exploring the feasibility and effectiveness of fully integrating blockchain technology into onboarding systems, particularly in large-scale organizations (Belotti et al., 2019; Dong et al., 2021).

Inconsistent Verification of Employee Credentials: The Verification of candidates' qualifications and previous employment remains a challenge in the onboarding phase. Many companies continue to rely on third-party verification services, which can be time-consuming and prone to inaccuracies. Blockchain technology can offer a decentralized solution to securely and instantly verify credentials such as educational background, work history, and professional certifications. The research gap lies in understanding the practical implementation and security measures needed to ensure that blockchain technology can handle such sensitive personal data without compromising privacy (Stone & Deadrick, 2015b).

Security and Transparency in Offboarding Processes: The offboarding process, particularly in the case of employee exit interviews, data transfer, and access termination, can be prone to security vulnerabilities and a lack of transparency. Many organizations still struggle to securely manage

employee data post-employment. Blockchain technology, with its immutable and transparent nature, can solve these issues by securely storing data access records and ensuring clear audit trails. However, there is limited research on how blockchain technology can be systematically incorporated into offboarding procedures to guarantee that all actions are tracked and irreversible (Nayak & Park, n.d.; Wei et al., 2020).

Data Privacy Concerns in Blockchain Technology-Based HRM: One of the major concerns surrounding blockchain technology in HR is data privacy. In both the onboarding and offboarding processes, the transparency of blockchain technology might clash with the need for confidentiality, particularly regarding sensitive employee information. Although blockchain technology can help mitigate fraud and reduce errors, there is a significant gap in understanding how a blockchain technology's transparency feature can be balanced with strict data privacy regulations, such as GDPR. However, little research has been conducted on how blockchain technology can be designed to protect personal data while ensuring compliance with legal frameworks (Bodkhe et al., 2020; Tasatanattakool, 2018b).

Integration with Legacy HR Systems: Another research gap lies in the integration of blockchain technology with existing HR systems. Many organizations still operate on traditional centralized systems that are not compatible with blockchain technology. In the context of onboarding and offboarding, HR departments face the challenge of coordinating blockchain technology-based verification processes using legacy systems for employee records, payroll, and benefits management. Further studies are needed to explore the technical feasibility of integrating blockchain technology with the existing HR infrastructure and how these systems can be transitioned without disrupting day-to-day operations (Chillakuri, 2020; Chillakuri & Attili, 2022).

Scalability Issues in Blockchain Technology for HR Applications: Blockchain technology faces scalability challenges, particularly when handling large amounts of data, as seen in employee record management. In both onboarding and offboarding, the sheer volume of transactions, including background checks, employment history, and performance reviews, could overwhelm blockchain technology systems if not scaled properly. There is a lack of research on how blockchain technology can be effectively scaled to manage the volume and diversity of HR data, particularly in large organizations with a high turnover rate (Madhani, 2022; Squarepants, 2022).

Blockchain Technology's Role in Addressing Bias in Recruitment and Offboarding: Human bias is an ongoing issue in both onboarding (recruitment) and offboarding (performance evaluation and exits). By providing a transparent and auditable record of decisions, blockchain technology has the potential to reduce bias in recruitment and ensure fair treatment during offboarding processes. However, there is insufficient research exploring how blockchain technology can be leveraged to eliminate unconscious bias in these processes, especially considering the complex nature of human decision-making and the challenges of creating bias-free blockchain technology systems (Gomathi Sankar, 2022; M. Mallick et al., 2022).

Training and Adoption Challenges: For blockchain technology to be fully integrated into the onboarding and offboarding processes, HR professionals must undergo training and development to effectively utilize the technology. However, there is limited research on how blockchain technology adoption can be facilitated in HR departments, especially given the resistance to change and the lack of technical expertise in many organizations. Understanding the training needs and adoption barriers specific to HR teams is a critical gap that requires more attention, particularly in terms of ensuring the smooth integration of blockchain technology into HRM practices (Dong et al., 2021).

Addressing these research gaps is essential for harnessing the full potential of blockchain technology in transforming HR onboarding and offboarding practices. By tackling issues such as credential verification, data privacy, and scalability, blockchain technology can offer a more secure, transparent, and efficient solution to longstanding challenges in HR management.

2.6. Summary

This chapter presents a comprehensive literature survey focused on the integration of blockchain technology into human resource management, specifically addressing the onboarding and offboarding processes of employees. This chapter systematically reviews the existing research, highlighting various studies that explore the transformative potential of blockchain technology in enhancing the transparency, security, efficiency, and accountability of HR practices. The authors outline the problems currently faced in HRM, such as fraud and slow administrative processes, and discuss how blockchain technology can effectively address these issues. They emphasize the need for organizations to adopt innovative solutions that can streamline HR functions, ultimately

benefiting both employees and employers. Additionally, the chapter acknowledges critical gaps in the current literature on blockchain technology applications in HRM. Further empirical research is required to validate the theoretical frameworks and explore the practical implications of implementing blockchain technology in onboarding and offboarding scenarios. The methodology section describes a thorough bibliometric analysis to collate relevant studies from reputable scientific databases. This systematic approach ensures a robust evaluation of the existing literature, pinpointing the most pertinent works that contribute to understanding the challenges and opportunities offered by blockchain technology in human resource management. This chapter lays the groundwork for future research and development in leveraging blockchain technology to enhance organizational HR processes and foster a more effective and secure employment lifecycle.

Chapter 3: Research Methodology

This chapter outlines the research methodology adopted to explore the implementation of blockchain technology in human resource onboarding and offboarding processes in the automobile industry. This chapter serves as the foundation for this study by detailing the systematic procedures, tools, and techniques employed to address the research objectives and answer the proposed questions. By utilizing a structured approach, the methodology ensures the reliability, validity, and relevance of the findings and provides a robust framework for data collection, analysis, and interpretation. The chapter begins with a description of the research design, emphasizing its suitability for the objectives of the study. It elaborates on the chosen qualitative method to capture comprehensive insights into HR professionals' perspectives. Key aspects such as data sources, participant selection criteria, and ethical considerations were highlighted to ensure the study's rigor and transparency. This chapter explains the use of specific tools, that is, semi-structured interviews, to gather data and interpret stakeholder sentiments regarding blockchain technology integration. Advanced analytical frameworks and software, including thematic analysis, content analysis, sentiment analysis, and blockchain technology implementation, were employed to ensure precision and depth in understanding the phenomena under investigation. By clearly defining the research methodology, this chapter establishes the groundwork for subsequent chapters that present the findings and discuss their implications, aligning the study with academic rigor and practical relevance.

This chapter is divided into nine sections: Section 3.1 provides the fundamentals of the research methodology. Section 3.2 discusses the research design of this study. Sections 3.3, 3.4, 3.5, and 3.6 discuss phases 1, 2, 3, and 4, respectively. Section 3.7 provides data fields for the onboarding and offboarding processes. Section 3.8 discusses the ethical considerations of this research. Finally, section 3.9 provides a summary of this chapter.

3.1. Introduction to Research Methodology

This section presents the research methodology employed to investigate the application of blockchain technology in human resource onboarding and offboarding processes in the automobile industry. This explains the qualitative research techniques adopted to effectively address the research objectives. By focusing exclusively on qualitative methods, this study captures nuanced

insights from HR professionals and industry experts, ensuring an in-depth understanding of the processes, challenges, and opportunities involved.

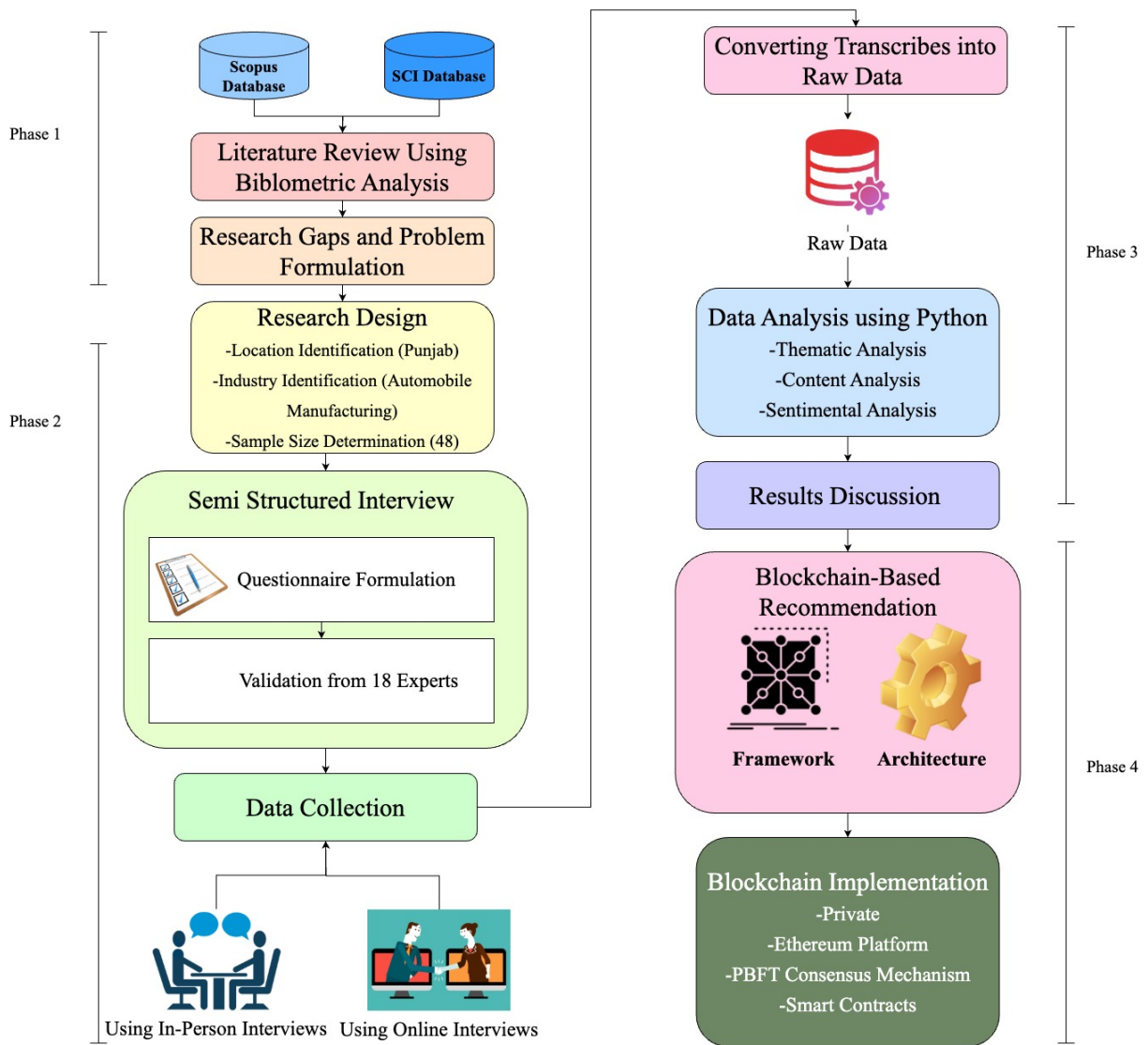


Figure 3.1. Research methodology for blockchain technology-based human resource onboarding and offboarding practices

The methodology was divided into four distinct phases, as shown in Figure 3.1. This methodology ensured a structured approach. The first phase involved a bibliometric analysis of the existing literature to identify gaps and formulate the research problem. The second phase included data collection through semi-structured interviews, utilizing purposive sampling to select HR experts from the automobile sector. This ensures the inclusion of diverse perspectives relevant to the

industry. The third phase focused on thematic, content, and sentiment analysis of the interview data, which provided a detailed understanding of the current state and potential improvements in HR practices. The fourth phase proposes a blockchain technology-based framework and architecture tailored to the automobile industry and implements the proposed solution using Ethereum technology. This phase demonstrated the practical feasibility and efficacy of the framework for streamlining HR operations.

The relevance of this methodology lies in its ability to systematically address research questions while bridging the gap between theoretical insights and practical implementation. This qualitative approach ensures that the voices and experiences of HR practitioners are thoroughly considered, leading to a blockchain technology-based framework that aligns with industry-specific requirements. The integration of a practical implementation phase further solidified the study's contribution to both academic and practical domains.

3.2. Research Design

This section outlines the research design employed to explore the implementation of blockchain technology in human resource onboarding and offboarding processes in the automobile industry. The research design serves as a blueprint for conducting the study, ensuring a systematic and coherent approach to achieving the research objectives. Given the exploratory nature of this study, a qualitative design was adopted to capture detailed insights from industry experts and HR professionals (Khalid Alrashedi, 2024; Tyskbo, 2019). The research progresses through multiple phases, beginning with a bibliometric analysis of the existing literature to identify gaps and refine the research problem (Albi, 2024). This was followed by semi-structured interviews with purposively selected participants to gather rich context-specific data (Racolța-Paina & Irini, 2021; Salah et al., 2020b). The collected data were subjected to thematic, content, and sentiment analysis to uncover patterns and sentiments, offering a comprehensive understanding of the processes (Racolța-Paina & Irini, 2021). Finally, the design incorporates the development and implementation of a blockchain technology-based framework and architecture, demonstrating its applicability using Ethereum technology (C. Zhang et al., 2020). By structuring the research in these stages, the design ensures that the findings are academically robust and practically relevant.

An overview of the key elements of the research design employed to explore blockchain technology implementation in HR onboarding and offboarding processes in the automobile industry is provided in Table 3.1.

Table 3.1. Summary of research design components

Component	Details
Research Type	A qualitative research approach to explore challenges and opportunities in HR onboarding and offboarding processes.
Research Methodology	Exploratory research design utilizing thematic, content, and sentiment analysis to identify patterns and insights.
Data Collection Methods	Semi-structured interviews with HR professionals in the automobile industry; validated questionnaire by 18 experts.
Sampling Strategy	Purposive sampling of 54 HR professionals from the Punjab automobile manufacturing sector.
Data Analysis Plan	Thematic, content, and sentiment analysis using Python tools to extract patterns, key themes, and emotional tones.
Research Setting	Focused on the automobile manufacturing sector in the Punjab region, addressing industry-specific HR challenges.

3.2.1. Phases of the Research Process

The research process was meticulously structured into four distinct phases, as depicted in Figure 3.1, ensuring a systematic and comprehensive investigation into the application of blockchain technology in human resource onboarding and offboarding processes within the automobile industry. Each phase was designed to address specific objectives by integrating theoretical exploration and practical implementation.

Phase 1: Literature Review and Problem Formulation

The initial phase involved an extensive literature review using a bibliometric analysis. Databases such as Scopus and SCI were used to identify relevant studies on HRM, onboarding, offboarding, and blockchain technology. This phase aimed to extract trends, highlight gaps in the existing research and refine the problem statement. The outcome of this phase provided the theoretical foundation for the study and validated the need to explore blockchain technology in HR practices. The details of this phase are provided in Chapter 2.

Phase 2: Research Design and Data Collection

In the second phase, the research design was established by focusing on qualitative methods. The study identified the context of the Punjab region and the automobile manufacturing sector. A total of 425 companies were found in the Punjab region. A sample size of 54 companies (HR professionals) was determined using purposive sampling. Out of these, 48 agreed to participate and provided their experiences. All the selected companies are working in different domains of automobile manufacturing. Some prominent companies include Hero Cycle Ltd., Swaraj Engines, Sonico Bikes Ltd., Avon Cycles, Hindustan Wheels Pvt. Ltd. and many more. Semi-structured interviews were conducted as the primary data-collection method. 18 experts from industry and academia validated the questionnaire to ensure relevance and clarity. Data collection was conducted using in-person and online interviews, which provided diverse perspectives from the industry.

Phase 3: Data Analysis

The third phase involved the transformation of the interview transcripts into raw data for analysis. Python programming was employed for the thematic, content, and sentiment analysis. Python data analysis techniques facilitated the extraction of patterns, key themes, and emotional undertones from the qualitative data (Abram et al., 2020; Alsaadi et al., 2022; Caughlin & Bauer, 2019; Saura et al., 2019). The results from this phase provided actionable insights into the challenges and opportunities in the onboarding and offboarding practices, as perceived by industry practitioners. Details regarding this phase are provided in Chapter 4.

Phase 4: Blockchain Technology-Based Recommendation and Implementation

The final phase integrates the findings from the previous phases to develop a blockchain technology-based framework and architecture. This phase includes the design and implementation of a blockchain technology solution using a private Ethereum platform. Features such as the Practical Byzantine Fault Tolerance (PBFT) consensus mechanism and smart contracts have been utilized to enhance transparency, efficiency, and security in HR practices (Abou Jaoude & George Saade, 2019; Soze, 2017; C. Zhang et al., 2020). The blockchain technology-based solution was tailored to address specific needs in onboarding and offboarding, thereby providing a practical and scalable recommendation for the industry. The details of this phase are provided in Chapter 5.

By structuring the research into these phases, this study ensures a thorough exploration of both the theoretical and practical dimensions, ultimately contributing to the advancement of blockchain technology applications in human resource management.

3.2.2. Research Type

This study employed a qualitative research methodology to explore and address the challenges in human resource onboarding and offboarding in the automobile industry. The qualitative approach was chosen because of its ability to provide an in-depth understanding of complex processes and stakeholder perspectives, which are crucial for designing and implementing innovative solutions, such as blockchain technology. Unlike quantitative research that focuses on numerical data and statistical relationships, qualitative methods allowed this study to delve into the contextual, procedural, and operational aspects of HR processes. By emphasizing rich narrative data, this approach enables a comprehensive exploration of the limitations of current practices and the potential role of blockchain technology in overcoming these challenges. The cornerstone of this qualitative research is semi-structured interviews, which offer a balanced approach between guided questioning and flexibility. A structured interview guide was developed to address key themes, including existing gaps in onboarding and offboarding, stakeholder experiences, and blockchain technology's applicability. This structure ensured consistency across interviews, while flexibility allowed the interviewers to probe emerging themes and clarify participant responses. The questionnaire was validated by 18 subject-matter experts to ensure its relevance, comprehensiveness, and alignment with the study objectives. This validation step enhanced the reliability and rigor of the data-collection process.

The qualitative methodology was particularly effective in addressing the unique context of the automobile manufacturing sector, which presents distinct HR challenges owing to its operational scale, workforce diversity, and regulatory requirements. The study explored critical areas, such as scalability issues, compliance with industry regulations, and concerns over the confidentiality and security of employee data during onboarding and offboarding. These context-specific insights are instrumental in shaping the proposed blockchain technology-based framework and architecture. Qualitative research was deemed the most suitable approach because of its exploratory nature. This research sought to generate new insights and solutions rather than test predefined hypotheses or measure variables. The purposive sampling of 48 HR professionals from the Punjab automobile

manufacturing sector further reinforced the suitability of the qualitative methods, as it provided detailed and descriptive data essential for understanding the nuances of HR processes. Quantitative research methods, although valuable for statistical analysis, were not appropriate for capturing the multifaceted and human-centered aspects of this study.

Additionally, the collected qualitative data were analyzed using thematic and sentiment analysis techniques to ensure a structured and robust interpretation of participant responses. These analyses not only provided a deeper understanding of stakeholder perspectives but also directly informed the development of a blockchain technology-based framework and its subsequent implementation. This comprehensive and iterative approach bridged the gap between theoretical exploration and practical applications, culminating in actionable recommendations tailored to the specific needs of HR processes in the automobile industry.

3.3. Phase 1: Literature Review and Problem Formulation

A robust literature review and problem formulation process were conducted to establish the foundation for this research. The primary data sources for the review included the Scopus and Science Citation Index (SCI) databases, chosen for their extensive coverage of peer-reviewed literature and high citation indices. The Scopus database offers multidisciplinary insights and robust citation data, whereas the SCI database complements this by focusing on high-quality scientific publications. Together, these databases facilitate the identification of critical studies, influential authors, and emerging themes in human resource management, onboarding, offboarding, and blockchain technology applications. The literature review process followed a structured methodology using a bibliometric analysis. Relevant keywords such as “HR onboarding,” “blockchain technology in HR,” and “employee lifecycle management” were used to query the databases. Boolean operators refined the search process to exclude unrelated studies. The inclusion criteria ensured that only peer-reviewed journal articles, conference papers, and books from the last decade were analyzed. This approach enabled the identification of key themes, including the integration of blockchain technology into HR functions, challenges in onboarding processes, and the role of technology in employee lifecycle management.

Through a bibliometric analysis, significant research gaps were identified. The findings revealed a limited exploration of blockchain technology in HR processes, particularly in onboarding and

offboarding. Although blockchain technology has demonstrated potential in domains such as finance and supply chain management, its application in HRM remains underexplored. Furthermore, there is a scarcity of empirical studies that assess the effectiveness of blockchain technology in HR operations, especially in the automobile manufacturing sector. Existing frameworks often focus on traditional HR models and fail to address the evolving technological landscape and its implications for employee life cycle management. Another gap highlighted was the absence of comprehensive frameworks integrating blockchain technology to enhance the automation, transparency, and security of HR processes. Based on these insights, a problem statement for this study was formulated to address these gaps. The inefficiencies, lack of transparency, and security vulnerabilities in HR processes, particularly in onboarding and offboarding, highlight the pressing need for technological innovation. Despite the growing interest in blockchain technology, its potential to resolve these challenges has not been fully leveraged in the HR domain, particularly in the automobile manufacturing industry. This study aims to fill this gap by developing a blockchain technology-based framework to enhance the efficiency, transparency, and security of HR operations.

This phase of the research provided a clear direction for addressing the identified gaps, defined the research objectives, and laid the groundwork for the proposed framework and methodology. A detailed literature review is presented in Chapter 2.

3.4. Phase 2: Data Collection

The second phase of the research involved a systematic and methodical approach to data collection to effectively address research objectives. This phase focused on gathering qualitative insights through semi-structured interviews to ensure a comprehensive understanding of the challenges and opportunities in HR onboarding and offboarding processes in the automobile manufacturing industry. The data collection process was structured to include a questionnaire as the primary tool for conducting the interviews. To validate the questionnaire and ensure its relevance, feedback was sought from experts in the field including HR practitioners, blockchain technology specialists, and academic researchers. The collected data served as the foundation for subsequent phases, where they were processed and analyzed to extract meaningful insights. This phase ensured that the

research was grounded in empirical evidence, enabling the development of blockchain technology-based recommendations tailored to the identified challenges in HR processes.

3.4.1 Research Context and Scope

The context and scope of this study were defined to address the application of blockchain technology in HRM processes, particularly focusing on onboarding and offboarding practices. This study was conducted in Punjab, India, specifically targeting the automobile manufacturing industry. This sector was selected because of its prominence as a significant contributor to India and Punjab's economy and its complex HR processes, which make it an ideal candidate for innovative technological interventions, such as blockchain technology. To identify the population for this study, 425 companies within the automobile manufacturing sector were considered. The selection of these companies is based on three critical factors.

Foundation Year: Companies with sufficient operational history were prioritized to ensure that established HR processes and practices could be assessed.

Total Turnover: Firms with substantial revenue were selected, as they are likely to have structured HRM systems in place and resources for adopting blockchain technology solutions.

Number of Employees: Organizations with a considerable workforce—were included to explore onboarding and offboarding practices on a larger scale, making the study more impactful.

Using these criteria, the initial population was narrowed to ensure that the study targeted relevant and representative organizations. Subsequently, Cochran's formula was applied to determine the sample size to ensure statistical reliability. Based on this calculation, a sample size of 54 companies was identified. However, during the data collection phase, a convenience sampling technique was employed to address logistical constraints and improve participation rates. This approach resulted in data collection from 48 companies, representing a robust and diverse sample of the target industry. These companies deal with multiple portfolios like interior, spare parts, wheel manufacturing, etc. This sampling approach was justified to achieve a balance between statistical rigor and practical feasibility. The selection criteria ensured that the participating organizations provided meaningful insights into the challenges and opportunities associated with HRM processes in the automobile sector. Moreover, the convenience sampling technique allowed the research to overcome challenges related to the accessibility and availability of respondents, ensuring the inclusion of companies that were actively engaged in HRM practices.

By focusing on 48 companies within this context, this research established a comprehensive foundation to explore the integration of blockchain technology in HRM, providing valuable insights into current practices, identifying pain points, and proposing a blockchain technology-based framework for improvement. This structured approach ensures that the findings are relevant and applicable to the broader context of HRM in the automobile industry.

3.4.2 Semi-Structured Interviews

Semi-structured interviews were chosen as the primary qualitative data collection method to gain in-depth insights into the challenges, practices, and opportunities related to HRM processes, specifically onboarding and offboarding. This approach allows for a balance between structured questioning and flexibility to explore participants' perspectives in greater depth. The semi-structured format ensured that the interviews addressed key aspects of the research objectives while leaving room for respondents to elaborate on their experiences and opinions.

The formulation of the interview questionnaire was guided by the primary objectives of this study, which focused on understanding the limitations of current HRM practices and exploring the feasibility of blockchain technology integration. The questions were meticulously designed to capture both qualitative and contextual data, ensuring that they were aligned with the research's theoretical framework and practical goals. The development process began with an extensive review of existing literature and practices in HRM, onboarding, offboarding, and blockchain technology. This review helped identify the critical themes and gaps that need to be addressed. Key areas of focus include the efficiency and transparency of onboarding and offboarding processes, existing challenges, data management practices, and perceptions of blockchain technology as a potential solution.

The questionnaire included open-ended questions to encourage participants to share their insights without restrictions, thereby fostering a deeper understanding of their experiences. For instance, questions were framed to explore participants' perspectives on issues, such as the challenges they face in the current onboarding and offboarding processes. A rationale for each question was established to ensure its relevance to the research objective. For example, questions on transparency and data security were included because these are critical aspects in which blockchain technology offers significant advantages. Similarly, questions about process inefficiencies were designed to identify the pain points that blockchain technology could address.

3.4.2.2 Validation Process

The validation process was a critical step in ensuring the credibility, reliability, and relevance of the semi-structured interview questionnaire developed for this study. To achieve this, the questionnaire was subjected to an expert review process involving 18 experts from diverse but relevant fields, including human resource management, blockchain technology, and academic research. The details of the final questions for the semi-structured interviews are available in Appendix 1. This multidisciplinary approach to validation ensured that the questionnaire effectively captured all the dimensions of the research objectives. Experts were selected based on their professional experience and expertise. HR professionals with extensive knowledge of the onboarding and offboarding processes were consulted to ensure that the questions were practical and reflective of real-world challenges. Blockchain technology specialists provided feedback on the technical feasibility and alignment of questions with the technological focus of the research. Academic researchers have offered guidance on the methodological rigor and relevance of the questions in the context of qualitative research.

The experts reviewed the questionnaire against several key criteria:

Clarity and Comprehensibility: Ensuring that the questions were unambiguous, concise, and easy to understand. This was crucial to avoid misinterpretation and to ensure that participants could provide meaningful answers.

Relevance to Research Objectives: Each question was directly aligned with the research objectives, specifically focusing on HRM challenges and the potential integration of blockchain technology.

Comprehensiveness: The questionnaire covered all critical aspects of the research, including data security, transparency, and process inefficiencies in onboarding and offboarding.

Practicality: Assessing whether the questions were realistic for participants to answer based on their experience and knowledge without causing respondent fatigue.

During the validation process, experts provided detailed feedback and recommendations for improvement. For example, they suggested rephrasing certain technical questions about blockchain technology to make it more accessible to HR professionals who may not have a strong technical background. Similarly, they recommended including probing questions to delve deeper into specific HRM challenges, ensuring that the collected data would be sufficiently detailed for

analysis. Based on expert feedback, the questionnaire was subjected to an iterative refinement. Redundant or unclear questions were eliminated and additional questions were incorporated to address the gaps identified during the review process. The final version of the questionnaire reflected a well-balanced, targeted, and contextually relevant tool that effectively captured the perspectives of the participants while addressing the overarching goals of the research. The validation process adds rigor to the data collection methodology, enhancing the trustworthiness and applicability of the findings. By leveraging the expertise of professionals across disciplines, the study ensured that the questionnaire was robust and capable of eliciting meaningful insights that would contribute significantly to achieving the objectives of the study.

3.4.2.3 Data Collection Methods

The data collection process for this research was strategically designed to ensure the acquisition of rich, reliable, and diverse insights while maintaining methodological rigor. A purposive sampling technique was employed to select participants who were most likely to provide relevant and meaningful information in line with the research objectives. This approach was particularly suitable given the focus of the study, which targeted HR professionals and decision-makers with experience in onboarding and offboarding processes, and knowledge of technological interventions in human resource management. Purposive sampling was selected for its ability to identify participants who met the specific criteria critical to the goals of the study. Participants were selected from 48 automobile manufacturing companies that were identified as part of the research scope. The selection criteria for participants included their roles in HR functions, decision-making authority, and familiarity with the onboarding and offboarding procedures. This ensured that the collected data were directly relevant to exploring the challenges in HR processes and the potential application of blockchain technology.

The interviews were conducted using a combination of in-person and online modes, offering flexibility and accessibility to participants while accommodating their preferences and logistical constraints. This dual-mode approach was adopted to maximize participation and ensure geographic and demographic diversity in the dataset. In-person interviews were conducted primarily with participants located close to the researcher's operational area. This method facilitated deeper interaction, enabling the researcher to observe non-verbal cues and build rapport with the participants. In-person interviews were particularly beneficial for engaging participants

in discussions on complex or sensitive topics, such as inefficiencies in HR processes and concerns about data security in current systems. Online interviews were conducted with participants located in distant regions or those unable to meet in person because of time or logistical constraints. These were facilitated through video-conferencing platforms, ensuring visual interaction to replicate the dynamics of face-to-face conversations. Online interviews provide a convenient and cost-effective means of gathering data from geographically dispersed participants, ensuring that the research captures a diverse range of perspectives. Appendix 2 provide sample transcript from data collection phase.

3.5. Phase 3: Data Analysis and Interpretation

The third phase of this research, Data Analysis and Interpretation, focused on systematically examining the data collected during semi-structured interviews to derive meaningful insights aligned with the research objectives. This phase is critical for uncovering patterns, identifying trends, and generating actionable recommendations regarding the integration of blockchain technology into human resource management processes, particularly onboarding and offboarding. A combination of qualitative analysis techniques was employed to ensure a comprehensive understanding of the data while maintaining objectivity and rigor throughout the process. The data collected from the interviews were transcribed into raw text to create a structured dataset for further analysis. The use of thematic, content, and sentiment analyses allowed for an in-depth exploration of participant responses. Thematic analysis facilitated the identification of recurring themes and sub-themes related to the challenges, inefficiencies, and security concerns in HR processes, whereas content analysis helped quantify and categorize the key concepts discussed by participants. Sentiment analysis was employed to gauge participants' attitudes toward existing systems and the proposed blockchain technology-based solutions, providing valuable insights into the perceived feasibility and acceptance of innovative technologies (Abram et al., 2020; Alsaadi et al., 2022).

The rationale for employing these analytical methods is their ability to extract qualitative and quantitative insights from textual data. Thematic analysis ensured that the nuances of participant responses were captured, whereas content analysis added an empirical dimension by identifying the frequency of specific terms or concepts. Sentiment analysis, on the other hand, enables the

assessment of emotional and attitudinal dimensions, offering a balanced perspective on the collected data. This phase also included rigorous interpretation of the analyzed data to align the findings with the objectives of the study. By synthesizing the results from various analyses, this phase contributes to the identification of gaps in current HRM practices and the formulation of blockchain technology-based recommendations. The insights derived from this process not only addressed the research questions but also provided a solid foundation for developing a robust framework for implementing blockchain technology in HRM. Overall, the data analysis and interpretation phase played a pivotal role in transforming the raw data into actionable knowledge, ensuring the relevance and validity of the study's conclusions (Chung & Chen, 2019).

3.5.1 Data Preparation

The initial step of the data analysis process involved converting interview transcriptions into raw data for analysis, which was accomplished using Python-based tools and libraries. This stage was critical for transforming the qualitative data from semi-structured interviews into a structured and analyzable format. By leveraging Python's capabilities, the process was automated, efficient, and accurate, thereby ensuring the integrity of the raw data while reducing manual errors (Alsaadi et al., 2022; Caughlin & Bauer, 2019).

The interview recordings were first transcribed into text using speech-to-text tools, such as Python's speech recognition library. This automated transcription process enables swift conversion of verbal data into a textual format. The generated transcriptions were then cleaned and preprocessed using the Python library Natural Language Toolkit (NLTK) and spaCy. These libraries facilitated the removal of irrelevant information, such as filler words, repeated phrases, or transcription artifacts, ensuring the clarity and relevance of the dataset. Once cleaned, the text data were organized into a structured format, that is, a CSV file, using Python's Pandas library. This organization allowed each interview response to be labeled with unique identifiers, such as participant ID, organizational role, and response category, for easy traceability. Python scripts were used to segment the responses into thematic categories, ensuring that the data were aligned with the research objectives (Alsaadi et al., 2022; Saura et al., 2019).

The use of Python in this stage was justified owing to its robust text-processing capabilities, flexibility, and scalability. Unlike manual transcription or other software, Python offers the advantage of full control over the preprocessing workflow, ensuring that each step, from

transcription to cleaning, is customized to the research requirements. The resulting raw data served as the foundation for advanced analysis, such as thematic, content, and sentiment analysis, ensuring a structured approach to interpreting qualitative inputs from the participants. This Python-based data preparation process provided a reliable and automated framework for converting interview transcriptions into raw data, setting the stage for deeper insights during the subsequent phases of analysis. The structured and clean dataset ensured that the findings were grounded in high-quality and well-organized data (Alsaadi et al., 2022; Caughlin & Bauer, 2019).

3.5.2 Data Analysis Tools and Techniques

In this phase, the raw data obtained from the interview transcriptions were analyzed using Python as the primary tool. Python's extensive libraries and frameworks for data processing and analysis make it an ideal choice for conducting comprehensive and efficient qualitative analyses. The analysis involved three key methodologies: thematic, content, and sentiment analyses. Each technique was selected to address specific research objectives and uncover meaningful insights from the data.

Thematic Analysis: Thematic analysis was employed to identify and categorize the patterns or themes within the interview responses. Python's Natural Language Toolkit (NLTK) and spaCy libraries were used to preprocess the text, which included tokenization, stop-word removal, and lemmatization. Subsequently, recurring concepts and themes were extracted using techniques such as keyword extraction and clustering using Term Frequency-Inverse Document Frequency (TF-IDF) and Gensim. This process enables the identification of major topics and subtopics relevant to human resource onboarding challenges, innovative solutions, and blockchain technology integration. The thematic analysis provided a framework to organize the qualitative data into coherent categories, aligning with the objectives of the study (Abram et al., 2020).

Content Analysis: Content analysis was used to quantify the presence of specific words, phrases, or ideas within the data. Python's pandas and NumPy libraries were leveraged to create frequency distributions and analyze the prevalence of key terms. Additionally, matplotlib and seaborn libraries were employed to visualize word frequencies and trends across the dataset. This methodology allowed for the identification of dominant topics, aiding in quantifying the qualitative insights and reinforcing the findings from thematic analysis. By using content analysis, the study

highlighted the relative importance of various elements in the onboarding process, as perceived by the participants (Abram et al., 2020; Saura et al., 2019).

Sentiment Analysis: To further explore the data, sentiment analysis was conducted to evaluate the emotional tone of the participants' responses. Python's TextBlob and VADER (Valence Aware Dictionary and Sentiment Reasoner) libraries were utilized to classify sentiments as positive, negative, or neutral. This analysis was particularly useful for understanding the emotional perceptions of participants regarding existing onboarding practices, technological interventions, and blockchain technology-based recommendations. The sentiment scores provided a quantitative dimension to the qualitative data, enabling the study to draw correlations between participants' sentiments and themes derived earlier (Abram et al., 2020; Saura et al., 2019).

Framework Development: The conceptual framework is designed based on data analysis to enhance HR onboarding and offboarding using blockchain technology. It integrates blockchain technology to improve transparency, security, and efficiency in HR operations while ensuring compatibility with existing systems. The architectural diagram presents the structural design, which includes modules for employee data management, contract verification, and task tracking. The flow diagram visualizes key processes, such as identity verification, document validation, and access control, while the implementation diagram details the technical setup, including smart contracts and distributed ledgers. Together, these elements provide a comprehensive guide for deploying a secure and efficient blockchain technology-based HR system. The frameworks were validated by experts from the IT and HR domain specialists. Appendix 3 provides the framework validation question for both the IT and HR domain specialists.

Rationale for Using Python: Python was chosen as the primary data analysis tool because of its versatility, scalability, and rich ecosystem of libraries tailored for text and sentiment analyses. Unlike other qualitative analysis tools, Python allows for complete customization of the analysis pipeline, ensuring that each methodology is tailored to the specific requirements of the research. Its open-source nature and extensive community support ensured that the analysis was cost-effective and methodologically robust. Moreover, Python's ability to integrate various techniques into a single workflow enables the seamless processing and analysis of large datasets. By employing Python-based tools for thematic, content, and sentiment analysis, this study ensured that the data were explored from multiple perspectives. This multifaceted approach not only

enriches the depth of the findings but also validates the results by triangulating insights across different methodologies. The comprehensive use of Python provided a solid foundation for interpreting the raw data and deriving actionable recommendations (Alsaadi et al., 2022; Caughlin & Bauer, 2019). Detailed data analysis and interpretation are described in Chapter 4.

3.6. Phase 4: Blockchain Technology Implementation

The fourth phase of the research focused on the practical implementation of blockchain technology to address the challenges associated with human resource onboarding and offboarding. This phase leverages the Ethereum blockchain technology platform, which is known for its decentralized architecture, smart contract capabilities, and wide adoption in various industries. By creating dedicated smart contracts for onboarding and offboarding operations, this study aimed to provide a secure, transparent, and efficient solution to improve HR management practices. Ethereum was chosen as the blockchain technology platform for this study because of its robustness and flexibility in handling smart contracts. The platform's support for Solidity, a high-level programming language specifically designed for writing smart contracts, has enabled the development of customizable and feature-rich solutions. Ethereum's decentralized network ensures immutability and enhances its data security and trust. These features align with the goals of this study, which aimed to establish a reliable system for recording and managing HR processes (Carter & Ubacht, 2018; Chen et al., 2018).

Separate smart contracts were developed for the onboarding and offboarding processes, catering to the distinct requirements of each operation. The onboarding smart contract was designed to streamline the process of integrating new employees into an organization. It encapsulates the entire onboarding workflow, from offer letter acceptance to the completion of initial documentation. Employee data recording is used to securely store critical information such as employee credentials, joining dates, and job roles. Automation is carried out to verify employee-provided documents, ensure authenticity, and reduce manual effort. Access management is used to grant controlled access to specific HR personnel to view or update onboard details (Mahapatra, 2020; C. Zhang et al., 2020).

The offboarding smart contract addresses operational and compliance challenges during employee exit. Exit formality tracking is used to record the status of tasks, such as clearance approvals,

return of company assets, and final settlement processing. The digital Proof of Exit is implemented to create immutable records of the exit process, reduce disputes, and ensure regulatory compliance. Revoke access is used to automatically revoke access to company systems and resources upon the completion of offboarding. Blockchain technology has been implemented to overcome the limitations of traditional HR management systems such as data silos, inefficiencies, and security vulnerabilities. The immutable and transparent nature of blockchain technology ensures that all operations, whether onboarding or offboarding, are auditable and tamper-proof. The decentralized framework eliminates the need for intermediaries and reduces operational costs and delays. By creating separate smart contracts for each operation, this study ensured that the processes were modular, scalable, and tailored to the specific requirements of HR management (Dai et al., 2019; Sharif & Ghodoosi, 2022).

Ethereum's widespread adoption and community support have provided a reliable foundation for this implementation. The platform's smart contract functionality ensures the automation of repetitive tasks, minimizing manual intervention and human errors. Moreover, Ethereum's interoperability features allow seamless integration with existing HR systems, ensuring a smooth transition without disrupting the ongoing operations. The platform's energy-efficient upgrades, such as Ethereum 2.0, further align with the sustainable goals of modern organizations. To ensure the functionality and security of the smart contracts, rigorous testing was conducted in a simulated environment. The test cases included scenarios such as incorrect data inputs, unauthorized access attempts, and contract execution failures. These tests validate the robustness and reliability of the proposed blockchain technology-based HR framework. The blockchain technology implementation phase demonstrates the potential of Ethereum-based smart contracts to revolutionize HR processes. By addressing the key challenges in onboarding and offboarding, the proposed solution ensures transparency, security, and efficiency in HR management. This phase serves as a foundational step toward integrating blockchain technology into the broader landscape of HR operations, paving the way for future innovation in this domain (Abou Jaoude & George Saade, 2019; Foroglou & Tsilidou, 2015; Huynh-The et al., 2023). The details of the blockchain technology implementation are discussed in Chapter 5.

3.7. Data Fields for Onboarding and Offboarding Processes

In this study, the methodological framework for data collection and management in the onboarding and offboarding processes was meticulously designed to ensure accuracy, relevance, and alignment with organizational objectives. The fields identified for onboarding and offboarding were derived through an in-depth understanding of HR practices in the automobile manufacturing industry, incorporating both practical necessities and theoretical insights. These fields serve as foundational components for capturing, analyzing, and managing data related to employee lifecycle management.

Onboarding Fields

The onboarding process is critical to ensuring the smooth transition of new employees into an organization. The data fields selected for onboarding encompass the essential information required to facilitate integration, compliance, and role-specific readiness. The fields were as follows:

Employee Identification: Includes a unique employee ID and full name to ensure accurate record-keeping and personalized data tracking.

Personal Information: date of birth, contact details, and emergency contact to address personal and emergency needs.

Identification and Qualification Documents: Covers government-issued identification, educational qualifications, and professional experience, ensuring compliance and verification of credentials.

Job-Specific Information: Encompasses role, department, technical skills, and training schedules to tailor onboarding processes to organizational requirements.

Health and Safety Certifications: Ensures compliance with industry standards and organizational safety protocols.

Employment Benefits: Details of the employee benefits package, including health insurance, allowances, and retirement plans, to clarify entitlements.

Acknowledgment and Credentials: Includes acknowledgment of policies and distribution of access credentials to enable seamless operational engagement.

Offboarding Fields

The offboarding process is equally critical for ensuring compliance, knowledge transfer, and maintaining organizational integrity during employee transitions. The fields identified for offboarding address various operational and legal issues, as outlined below.

Employee Identification: Includes employee ID and full name to retrieve and manage the exit-specific data.

Resignation Details: Record the reason and timeline for resignation, enabling HR to analyze attrition trends.

Property and Asset Return: Tracks the return of company-issued equipment, ensuring accountability and asset management.

Final Pay and Benefits Termination: Details of salary settlement, incentives, and benefits, ensuring financial compliance.

System Access Revocation: Ensures the immediate revocation of access credentials to protect sensitive organizational information.

Knowledge Transfer: Captures handover details to maintain continuity and minimize disruptions in workflows.

Exit Feedback and Legal Compliance: Collects employee feedback for process improvement and ensures compliance with labor laws.

Clearance Status: Monitors clearance approvals from relevant departments, confirming process completion.

Archived Records Location: Details of the archival of employee records for future reference and regulatory compliance.

Rationale: The inclusion of these fields ensures a holistic approach to onboarding by addressing organizational, regulatory, and employee-specific needs. Structured data allows for automated processes, effective monitoring, and enhanced decision-making. These fields provide a comprehensive structure for effectively managing offboarding processes. They address operational continuity, legal adherence, and organizational security, ensuring that employees' exits are handled professionally and efficiently. The identification and use of these fields align with the broader objectives of this research, which seek to enhance HR management practices through systematic data collection and analysis. By structuring the onboarding and offboarding data into well-defined

fields, the methodology ensures that all aspects of employee transition are comprehensively addressed. This structured approach also facilitates the application of advanced analytical tools, such as thematic and sentiment analysis, to derive actionable insights for the continuous improvement of HR processes. The detailed specification of the data fields for the onboarding and offboarding processes ensures a robust methodological framework. This framework not only supports the practical needs of the automobile manufacturing industry but also contributes to advancing HR management research.

3.8. Ethical Considerations

Ethical considerations form a critical component of this research, ensuring that all processes align with the established moral principles and legal standards. Given the sensitivity of the data and the involvement of human participants, ethical compliance was a priority at every stage of the study. This section outlines the measures taken to maintain ethical integrity, safeguard participants' rights, and ensure transparency and accountability throughout the research process. All participants involved in the study were provided with comprehensive information about the research objectives, procedures, and potential outcomes before their participation. The consent forms were designed to clearly articulate the purpose of data collection, ensuring that participants were aware of their roles and rights. Voluntary participation was emphasized, and participants were allowed to withdraw at any stage without any consequences. Informed consent is the cornerstone of ethical research that promotes transparency and respect for individual autonomy. Their trust and willingness to participate were fostered by ensuring that they understood the scope of the study.

Strict measures were implemented to protect the participant data. Personally identifiable information was anonymized using unique identifiers to ensure that individual identities could not be traced back to the data. Additionally, all collected data were securely stored and accessible only to authorized researchers. Maintaining confidentiality and anonymity protects participants from potential harm, including reputational or professional risks. It also encourages honest and open participation, which is essential for the validity of research findings.

To ensure the security of sensitive information, digital data is encrypted and stored in password-protected systems. For blockchain technology-related components, secure smart contracts were implemented to handle data with transparency and immutability, thereby reducing the risk of

unauthorized alterations. Access controls were also established to restrict data handling by qualified personnel. Robust data security measures are vital for preventing breaches and the misuse of sensitive information, particularly when handling employee records in the context of onboarding and offboarding processes.

This study was designed to minimize potential risks to the participants. Questions posed during the interviews and data collection were carefully crafted to avoid discomfort, distress, or harm. Participants were also given the option to skip questions that they were not comfortable answering. Non-maleficence, or the principle of "do no harm," ensures that research practices do not negatively impact participants, thereby upholding ethical standards and promoting trust.

The research findings are reported with complete honesty and integrity. Potential limitations, conflicts of interest, and biases were disclosed to maintain the transparency and reliability of this study. Ethical transparency in reporting ensures that the research is trustworthy and meaningfully contributes to the body of knowledge without misrepresentation or distortion.

Given the focus on the automobile manufacturing industry in India, this study was sensitive to cultural and organizational nuances. Efforts were made to align research practices with local norms and values, ensuring respect for the participants' cultural backgrounds. Cultural sensitivity fosters better engagement with participants and ensures that research is contextually relevant and ethically sound. By adhering to these ethical considerations, the research ensured a respectful, secure, and transparent process that safeguarded the rights and well-being of the participants. These measures not only uphold the integrity of the study but also contribute to its acceptance and validity in the broader research community.

3.9. Summary

This chapter systematically outlines the research methodology adopted to explore the application of blockchain technology in human resource onboarding and offboarding processes in the automobile manufacturing industry. It detailed a structured, multi-phased approach to ensure that the study was methodologically rigorous, addressing both the theoretical and practical aspects. The research design emphasizes a qualitative approach, leveraging bibliometric analysis, semi-

structured interviews, and blockchain technology implementation to achieve the objectives of the study.

The first phase involved a thorough literature review using databases such as Scopus and SCI with bibliometric tools employed to identify research gaps. This phase provides a theoretical foundation for the study and validates the need for blockchain technology in HR processes. The second phase focused on data collection using semi-structured interviews. Using purposive sampling, we selected 48 HR professionals from the Punjab automobile manufacturing sector. The data collection instruments were carefully designed and validated by 18 subject matter experts to ensure reliability, relevance, and clarity. In-person and online interview methods ensured inclusivity and maximize participation. The third phase involved data analysis and interpretation, where Python-based tools were used to process and analyze the data. Techniques such as thematic, content, and sentiment analyses provide nuanced insights into the challenges, inefficiencies, and potential solutions for HR onboarding and offboarding. These analyses not only uncovered recurring themes but also quantified the significance of key issues and evaluated the emotional perceptions of participants regarding existing HR processes and blockchain technology-based solutions. The final phase is dedicated to blockchain technology implementation, demonstrating the feasibility of Ethereum-based smart contracts for streamlining HR operations. Separate contracts for onboarding and offboarding were developed, incorporating essential features, such as data security, document verification, and system access control. This implementation addresses the limitations of traditional HR systems by providing transparency, automation, and tamper-proof record-keeping.

Additionally, ethical compliance was ensured through informed consent, data security, and cultural sensitivity. Participants' rights were safeguarded and all processes were aligned with established ethical principles to maintain transparency and trustworthiness. By dividing the methodology into clearly defined phases, this chapter lays the groundwork for exploring the role of blockchain technology in HRM. This bridged the gap between theoretical insights and practical implementation, contributing to the advancement of HR practices through innovative technological solutions. This comprehensive approach ensures that the research findings are both academically rigorous and practically relevant, paving the way for future research in this domain.

Chapter 4: Data Analysis and Interpretation

Data analysis represents a pivotal phase in the research process, bridging the gap between the raw information and actionable insights. This chapter outlines the tools and techniques employed to analyze the collected data, ensuring a structured and methodical approach for deriving meaningful conclusions. This research leverages Python, an open-source programming language renowned for its flexibility, extensive library support, and efficiency in handling complex data-related tasks. Python's ecosystem offers specialized libraries, including pandas, matplotlib, NLTK, and TextBlob, which collectively empower the researcher to process, visualize, and interpret data with precision. The analysis in this chapter adopts a multifaceted approach to achieve a well-rounded understanding of a dataset. Thematic analysis, a qualitative method, was employed to uncover recurring patterns and themes within the textual data, providing a framework to organize insights according to their relevance to the research objectives. Python scripts aid in automating the coding process, reducing manual effort while maintaining rigor and accuracy. In addition, a content analysis was conducted to systematically quantify and categorize textual data, enabling the identification of key trends and their frequency of occurrence. This method complements thematic analysis by offering numerical evidence to support identified themes. Python's ability to handle large datasets efficiently ensured that the analysis was scalable and comprehensive. Finally, a sentiment analysis was performed to evaluate the emotional tone of the collected data. By leveraging natural language processing (NLP) capabilities, this technique gauges the polarity (positive, negative, or neutral) of the opinions expressed within the dataset. This step is crucial for understanding stakeholder perspectives and identifying the underlying sentiments that influence behavior or decision-making processes. Together, these analytical methods provide a holistic view of the data, ensuring that both the qualitative and quantitative dimensions are considered. This chapter demonstrates how Python tools streamlined the analysis process, contributing to the study's overall depth and reliability.

This chapter is divided into five sections: Section 4.1 provides the details of tools used for data analysis. Section 4.2 provides thematic analysis results and interpretation. Section 4.3 discusses the content analysis results and discussion. Section 4.4 provides the results and discussion of the sentiment analysis. Finally, section 4.5 provides a summary of this chapter.

4.1. Tools Used for Data Analysis

The success of any data analysis depends heavily on the tools employed to extract, process, and interpret information in a meaningful way. This section focuses on the specific tools utilized in this research, with a primary emphasis on Python, which has emerged as a dominant tool in the field of data analysis owing to its versatility and efficiency. Python is widely recognized for its ability to handle diverse data structures and large datasets with ease, offering researchers a powerful platform for conducting comprehensive analyses. Its extensive library ecosystem provides the flexibility to customize workflows according to the unique demands of research.

Several Python libraries played a critical role in this study. Pandas, a powerful data manipulation library, facilitates the organization, cleaning, and transformation of raw data into a structured format suitable for analysis. Its intuitive syntax allows for the seamless integration of data from various sources, thus simplifying the preprocessing phase. Matplotlib and Seaborn were leveraged for data visualization, enabling the creation of insightful charts and graphs to effectively illustrate patterns and trends. These visual tools not only enhance the interpretability of results but also make complex data accessible to broader audiences.

For text-based analysis, the Natural Language Toolkit (NLTK) and TextBlob are utilized for natural language processing tasks. These libraries are instrumental in tasks such as tokenization, stemming, and lemmatization, which are prerequisites for thematic and sentiment analysis. Furthermore, a word cloud was employed to generate visual representations of frequent terms, aiding in identifying the dominant themes in the data.

Python's integration with machine learning and NLP libraries, such as scikit-learn and spaCy, offers scalability and adaptability, making it ideal for advanced tasks, such as sentiment classification. These tools collectively streamlined the analysis process and ensured accuracy, consistency, and reproducibility. By harnessing Python's capabilities, this study achieves a seamless and efficient data analysis workflow, laying the foundation for extracting meaningful insights from the dataset.

4.1.1 Python as the Core Tool

Python has become an indispensable tool for data analysis, owing to its remarkable adaptability and ease of use. It has gained popularity across academic and industrial domains because of its

ability to process complex datasets and execute sophisticated algorithms with minimal code. Python serves as the primary platform for analyzing data and transforming raw information into meaningful insights. Its user-friendly syntax and modular design allow researchers to build flexible workflows tailored to specific analytical needs. Unlike traditional statistical software, Python can handle diverse types of data—structured, semi-structured, and unstructured—making it ideal for comprehensive research studies. Furthermore, as an open-source language, Python benefits from a global community of developers who contribute to its extensive library ecosystem, thereby ensuring access to cutting-edge tools for emerging analytical challenges.

The ability of Python to process large datasets efficiently is one of its most significant advantages. It offers robust support for cleaning, organizing, and transforming raw data into analyzable forms. Library pandas are particularly noteworthy for their ability to manipulate tabular data, enabling tasks such as handling missing values, merging datasets, and performing aggregations. Complementing pandas, NumPy provides support for high-performance mathematical operations, which are essential for numerical computations such as statistical analysis and matrix operations. Together, these libraries allow researchers to preprocess datasets systematically, ensuring data accuracy and reliability before proceeding with advanced analysis. This capability not only streamlines the workflow but also ensures reproducibility, which is critical for maintaining the integrity of scientific research.

In the textual data processing domain, Python is unmatched in its capabilities. The analysis of text, which forms a crucial component of this study, benefits immensely from Python's advanced natural language processing libraries, such as NLTK, TextBlob, and spaCy. These libraries facilitate critical tasks, such as tokenization, stemming, lemmatization, and part-of-speech tagging, enabling a deeper understanding of textual content. Sentiment analysis, one of the focal points of this research, relies on these tools to detect and classify emotional tones within the data, thereby uncovering the underlying perspectives and attitudes. Python also seamlessly integrates word frequency and co-occurrence tools to support thematic and content analysis, enabling researchers to identify recurring patterns or themes. Figure 4.1 represents the workflow diagram illustrating the usage of Python libraries for data analysis. It represents the sequence from data input to data cleaning, visualization, text analysis, and keyword representation with clear labels and modern design.

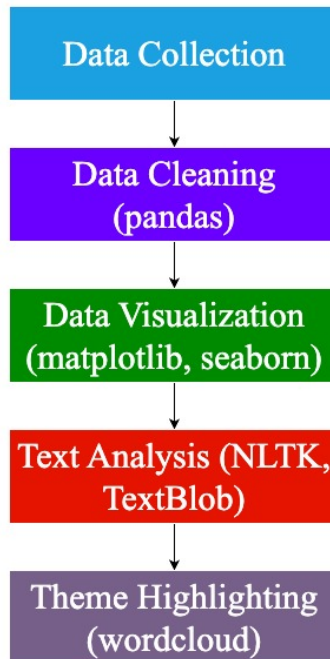


Figure 4.1. Workflow diagram for Python libraries usage

The visualization of the results is another area in which Python excels. Libraries such as matplotlib, seaborn, and pyplot provide dynamic and customizable visualization options, helping researchers communicate findings effectively. These libraries support a range of chart types, from simple line graphs and bar charts to complex heat maps and interactive dashboards. By converting numerical and textual insights into visual formats, Python ensures that the complex patterns and relationships within the data are accessible to a broader audience. This ability to represent data visually is instrumental in bridging the gap between raw analysis and decision-making processes.

4.1.2 Key Python Libraries Utilized

Pandas: Pandas is a cornerstone library in Python that offers a powerful framework for data cleaning, manipulation, and transformation. It provides data structures, such as DataFrames and Series, which simplify the handling of complex datasets. One of the key strengths of pandas is their ability to preprocess data efficiently, making them a preferred choice for tasks such as handling missing values, normalizing data formats, and reshaping datasets. For instance, when datasets contain null or inconsistent entries, pandas enable researchers to seamlessly replace, remove, or impute missing data. In addition, it supports operations such as filtering rows or columns based on specific criteria, which is essential for isolating relevant information. The

library's ability to merge, join, and aggregate data from multiple sources ensures that the datasets are structured in a manner conducive to further analysis. Pandas also integrates well with other Python libraries, enabling researchers to create end-to-end workflows without switching between the platforms. Its simplicity and extensive functionality make it an indispensable tool for data preprocessing in this research, where cleaning and organizing raw information is critical before applying advanced analytical techniques.

Matplotlib and seaborn: Effective data visualization is essential for uncovering patterns and trends within datasets. Matplotlib and seaborn are Python's premier libraries for this purpose. Matplotlib provides a foundational framework for creating static, interactive, animated visualizations. This supports a wide range of plots, including line graphs, bar charts, scatter plots, and histograms. For instance, in this study, matplotlib was used to depict trends in data over time or relationships between variables, making it easier to interpret complex datasets. Complementing matplotlib, seaborn simplifies the creation of aesthetically pleasing and informative visualizations. It is built on top of matplotlib and offers high-level interfaces for drawing statistical graphics such as box plots, violin plots, and heatmaps. The strength of Seaborn lies in its ability to integrate with pandas, allowing for direct visualization of DataFrame content with minimal code. For example, Seaborn's heatmaps are particularly useful for visualizing correlations in data, aiding the identification of relationships between key variables. Together, matplotlib and seaborn provide the tools needed to create visuals that not only convey insights effectively but also enhance the overall comprehension of the data's narrative.

NLTK and TextBlob: Natural Language Toolkit (NLTK) and TextBlob are two of Python's most robust libraries for natural language processing (NLP) and are indispensable for analyzing textual data in this research. NLTK provides a comprehensive suite of tools for text processing, including tokenization, stemming, lemmatization, and part-of-speech tagging. These functions are crucial for breaking down the raw text into analyzable components. For instance, tokenization divides text into individual words or phrases, forming the foundation for more advanced analysis. Stemming and lemmatization help standardize words to their root forms, reducing redundancy and improving the quality of results in thematic and content analysis. TextBlob, on the other hand, simplifies many NLP tasks and includes sentiment analysis capabilities, making it an excellent complement to NLTK. It assigns polarity and subjectivity scores to text, which are essential for determining the

emotional tone. In this research, NLTK and TextBlob are used to extract themes, analyze sentiment, and interpret textual patterns within the dataset, providing a deeper understanding of the qualitative aspects of the data. These libraries play a pivotal role in transforming unstructured textual information into meaningful information.

Table 4.1. Comparison table outlining the functionalities of the Python libraries

Library	Primary Function	Example Tasks	Output Type
pandas	Data cleaning, manipulation, and transformation	Handling missing data, reshaping datasets, filtering information, merging data	DataFrames, Series, Cleaned Data
matplotlib	Data visualization	Creating line graphs, bar charts, histograms, scatter plots	Static, interactive plots (graphs)
seaborn	Statistical data visualization	Visualizing relationships between variables, box plots, violin plots, and heatmaps	Aesthetically appealing plots
NLTK	Natural language processing (NLP)	Tokenization, stemming, lemmatization, part-of-speech tagging, chunking	Processed text, tokenized words
TextBlob	Text analysis and sentiment analysis	Sentiment analysis, polarity, and subjectivity scoring, text classification	Sentiment scores (polarity, subjectivity), processed text
wordcloud	Text visualization	Generating word clouds to visualize term frequency	Word cloud images, graphical representations of text data

The comparison in Table 4.1 outlines the core functions and applications of key Python libraries used in this research. pandas are primarily employed for data cleaning, manipulation, and transformation, making them essential for structuring and preprocessing datasets. It handles tasks such as managing missing data, reshaping datasets, and outputting data in the form of DataFrames or Series. Matplotlib and seaborn are focused on data visualization, with matplotlib providing tools for creating basic plots, while seaborn enhances these visualizations with more advanced statistical graphics, such as heatmaps and box plots. For text analysis, NLTK plays a central role in processing natural language through tasks like tokenization and stemming, while TextBlob simplifies sentiment analysis, providing polarity and subjectivity scores for text. Finally, the word cloud is used to visually represent term frequencies, creating word clouds that highlight key themes

in the data. Together, these libraries provide a robust framework for managing, visualizing, and analyzing both structured and unstructured data, thus enabling deeper insights into the research dataset.

Wordcloud: WordCloud is a visualization library that provides a unique way to represent the frequency of terms in textual data. By generating images in which the size of each word corresponds to its frequency, the word cloud offers an intuitive understanding of the dominant themes within a dataset. This library is particularly useful in qualitative research, where identifying prominent keywords is a critical step in thematic analysis. For example, a word cloud can visually highlight recurring phrases in survey responses or interview transcripts, offering immediate insights into key issues or sentiments expressed by participants. The library is highly customizable, allowing researchers to specify shapes, colors, and layouts to enhance the clarity and appeal of visualization. In this research, a word cloud was employed to complement thematic analysis by visually summarizing the textual data, enabling the quick identification of patterns that might not be immediately apparent through manual analysis. This visual representation serves as both an analytical tool and a means of presenting findings effectively to stakeholders, bridging the gap between technical analysis and comprehensible results.

4.1.3 Additional Libraries Supporting Analysis

In addition to the core libraries discussed earlier, several other Python libraries played a significant role in supporting and enhancing the data analysis process, particularly in handling numerical computations, advanced machine learning tasks, and high-performance natural language processing.

NumPy: NumPy is a fundamental library used for numerical computing in Python. It provides support for large multidimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays. NumPy is essential for performing efficient numerical operations, particularly when dealing with large datasets. Its array structure enables fast computation and vectorized operations, which significantly improves the performance of mathematical operations compared with standard Python lists. Tasks such as data transformation, statistical calculations, and handling large datasets were streamlined using NumPy's highly optimized functions. This library is particularly useful when working with large datasets that

require extensive numerical analysis or matrix-based computations, making it indispensable for data pre-processing and manipulation.

scikit-learn: Scikit-learn is one of the most widely used libraries for machine learning in Python. It provides simple and efficient tools for data mining and analysis, particularly for supervised and unsupervised learning algorithms. Scikit-learn plays a pivotal role in sentiment classification and other advanced machine-learning tasks. This library includes a wide range of algorithms for regression, classification, clustering, and dimensionality reduction. In addition, it provides tools for model selection, evaluation, and hyperparameter tuning. scikit-learn's implementation of popular algorithms such as support vector machines (SVM), decision trees, random forests, and k-nearest neighbors (KNN) makes it an essential library for building and evaluating predictive models, particularly in sentiment analysis and classification tasks.

spaCy: spaCy is an industrial-strength library for natural language processing (NLP) that is designed to handle large volumes of text with high efficiency. It is particularly known for its high performance in text-processing tasks such as tokenization, part-of-speech tagging, named entity recognition (NER), and dependency parsing. The ability of spaCy to process text at scale makes it an ideal choice for applications that require the analysis of large corpora of text data. Unlike other NLP libraries, spaCy focuses on providing fast and accurate results for complex linguistic tasks, making it an excellent choice for high-performance NLP workflow. It is often used for deep-text analysis, such as extracting named entities, parsing relationships between words, and identifying key information from unstructured text. spaCy can also be integrated with other libraries, such as scikit-learn, for machine learning tasks, enhancing its overall versatility in text-based data analysis.

Together, these additional libraries, NumPy, scikit-learn, and spaCy, extend Python's capabilities in numerical analysis, machine learning, and advanced NLP tasks. Their integration with core libraries such as pandas, matplotlib, seaborn, and NLTK ensures that the data analysis process is efficient, comprehensive, and capable of handling complex datasets.

4.1.4 Integration of Tools

The integration of Python libraries, such as pandas, matplotlib, seaborn, NLTK, TextBlob, NumPy, scikit-learn, and spaCy, plays a crucial role in streamlining data analysis workflows. These libraries were designed to complement one another, offering a cohesive environment for managing and

analyzing complex datasets. By leveraging the strengths of each tool, data scientists and researchers can ensure a smooth and efficient flow from data collection to final analysis while maintaining the integrity and reproducibility of the results.

At the core of this integration are pandas, which serve as the foundation for data manipulation and cleaning. This allows data to be efficiently loaded, cleaned, transformed, and prepared for further analysis. Once the data are structured properly, libraries such as matplotlib and seaborn take over, providing powerful visualization capabilities to explore trends, patterns, and correlations in the data. Visualization is an integral part of the analysis process, as it helps researchers gain a clearer understanding of the dataset before performing more complex analyses.

When dealing with textual data, tools such as NLTK, TextBlob, and spaCy are used. These libraries enable efficient natural language processing tasks, such as tokenization, sentiment analysis, and named entity recognition, which help extract valuable insights from the raw text. For instance, NLTK can preprocess text by tokenizing and stemming, while TextBlob can quickly assess sentiment polarity, allowing for a more informed analysis of textual datasets. SpaCy further enhances this workflow by offering high-performance NLP capabilities such as part-of-speech tagging and dependency parsing, which can be particularly useful when analyzing large volumes of unstructured text.

The integration of NumPy and scikit-learn is key when performing numerical computations and machine learning come into play. NumPy handles efficient mathematical operations, supports matrix manipulation, statistical analysis, and numerical modeling, which are crucial when dealing with large datasets. Scikit-learn is used to build predictive models, classify data, or perform clustering tasks, providing a machine learning framework that can be seamlessly combined with the data preprocessing steps handled by pandas.

This seamless integration across multiple tools ensures accuracy, efficiency, and reproducibility throughout the analysis pipeline. Each tool performs a specialized task, reducing the likelihood of errors and inconsistencies. The libraries work together to ensure that every step, from cleaning and transforming data to visualizing and analyzing it, is executed consistently. Furthermore, because all these tools are open-source and well-documented, researchers can replicate workflows with ease, ensuring that the results are reproducible and that the analysis can be verified by others.

By combining the functionalities of these libraries, researchers can build robust and effective data analysis pipelines. The integrated approach minimizes the need for redundant steps and manual interventions, enhances the overall workflow efficiency, and enables a more streamlined, automated analysis process.

4.2. Thematic Analysis

Thematic analysis is a powerful qualitative research method used to identify, analyze, and report patterns (themes) within a dataset. It involves interpreting the underlying meanings in data, particularly textual data and is widely applied in fields such as the social sciences, psychology, and human resource management. In the context of this research, thematic analysis plays a central role in uncovering key insights from interview transcripts, survey responses, and other text-based sources. By systematically organizing and interpreting the data, thematic analysis allows for the identification of recurring patterns or themes, offering a deeper understanding of the subject matter. This method is particularly valuable for extracting meaningful information from unstructured data, enabling researchers to move beyond surface-level observations to explore more nuanced findings. Through a combination of manual coding and automated tools, thematic analysis aids in the development of a comprehensive view of the data contributes to the overall analysis process, and ensures that the findings are both reliable and insightful.

4.2.1. Objective of Thematic Analysis in this Study

Thematic analysis plays a pivotal role in this study, focusing on exploring the application of blockchain technology in the HR onboarding and offboarding processes. The primary objective of employing thematic analysis is to systematically uncover and interpret patterns of meaning within qualitative data, thereby elucidating key themes and insights relevant to the integration of blockchain technology into HR practices.

Purpose and Focus

The thematic analysis in this study aims to:

Identify Key Themes: Identify and categorize recurring patterns, issues, and perceptions related to the onboarding and offboarding processes augmented by blockchain technology. This includes

understanding the challenges faced in current HR practices and exploring how blockchain technology can address these challenges.

Explore Perceptions and Experiences: To Delve into the perceptions, experiences, and viewpoints of HR managers and employees regarding the integration of blockchain technology. This involves capturing diverse perspectives on the benefits, concerns, and expectations associated with blockchain technology in the HR context.

Relevance to Research Goals

Thematic analysis aligns closely with the research goals by:

Providing In-depth Insights: By systematically analyzing qualitative data, thematic analysis offers detailed insights into the nuances of HR onboarding and offboarding practices. This allows for a comprehensive exploration of the operational challenges and strategic opportunities presented by blockchain technology.

Supporting Theory Development: Thematic analysis contributes to theory development in HR management and blockchain technology integration through the identification and interpretation of themes. It helps in grounding empirical findings within existing theoretical frameworks and the literature, thereby advancing knowledge in the field.

Contribution to Practical Applications

Furthermore, this thematic analysis aims to inform practical applications by:

Informing Decision-Making: By uncovering critical themes and insights, this analysis provides actionable information for HR professionals and organizational leaders. It facilitates informed decision-making in the adoption, adaptation, or optimization of blockchain technology in HR processes.

Enhancing Organizational Practices: Insights derived from thematic analysis can guide the development of tailored strategies and policies to enhance onboarding and offboarding experiences. This includes optimizing processes, enhancing data security measures, and improving overall employee satisfaction and retention rates.

4.2.2. Methodology for Thematic Analysis

Thematic analysis serves as a robust qualitative method to explore and interpret patterns of meaning within textual data, making it particularly valuable in studying complex phenomena, such as HR practices related to onboarding and offboarding, with a focus on blockchain technology integration. This section outlines the structured approach adopted in conducting thematic analysis.

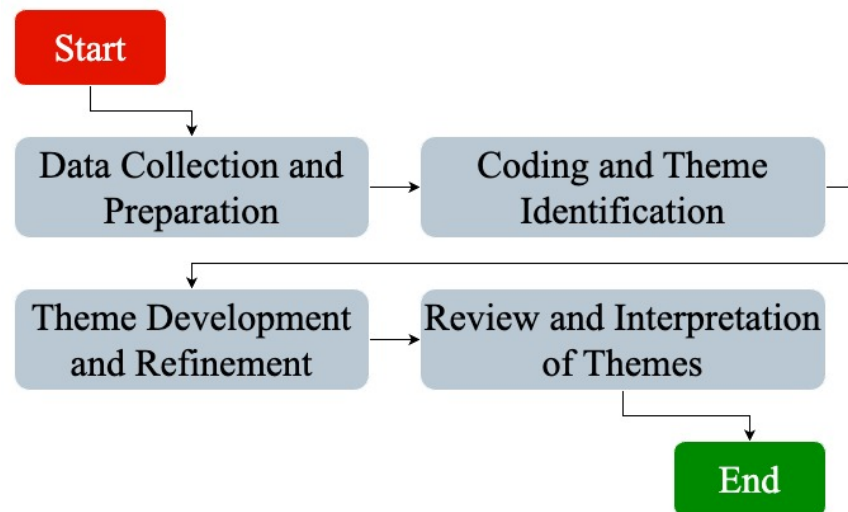


Figure 4.2. Sequential flow of thematic analysis methodology in blockchain technology-based HR practices

Thematic analysis involves a systematic approach to identify, analyze, and report patterns (themes) within qualitative data. This method enables researchers to uncover rich insights and understanding that emerge from participant responses, facilitating a comprehensive exploration of HR processes in relation to onboarding and offboarding. Figure 4.2 illustrates the systematic process of thematic analysis adapted for studying HR onboarding and offboarding practices integrated with blockchain technology.

Steps Involved in Conducting Thematic Analysis

Step 1: Data Collection and Preparation: The first step involved gathering qualitative data relevant to HR onboarding and offboarding practices, including interview transcripts, survey responses, and organizational documents. Ensuring data integrity and relevance is crucial for capturing a comprehensive view of participants' experiences and perceptions regarding blockchain technology.

Step 2: Coding and Theme Identification: During this phase, the collected data are systematically coded to identify meaningful patterns and themes related to the onboarding and offboarding processes. Initial coding involved segmenting the data into meaningful units, followed by focused coding to categorize these units into preliminary themes. Themes are derived from recurrent patterns in data, such as challenges in current onboarding practices or the perceived benefits of blockchain technology in data security during offboarding.

Step 3: Theme Development and Refinement: Identified themes undergo iterative refinement to enhance their clarity and coherence. This stage involves organizing related codes into broader themes and sub-themes that encapsulate the essence of the data. For instance, themes related to onboarding might evolve to include categories such as "lack of standardization" or "ineffective training protocols," whereas themes for offboarding could encompass "data privacy concerns" or "process inconsistencies."

Step 4: Review and Interpretation of Themes: The final step involves reviewing and interpreting refined themes within the context of HR onboarding and offboarding practices augmented by blockchain technology. This process aimed to extract meaningful insights and implications for practice and policy. Themes are examined in relation to the existing literature and theoretical frameworks, providing a deeper understanding of how blockchain technology integration can address current challenges and enhance HR processes.

By rigorously following these steps, this thematic analysis contributes to a nuanced exploration of HR onboarding and offboarding practices in the context of blockchain technology, offering valuable insights into both the challenges faced and potential benefits of adopting innovative solutions in organizational settings.

Theme Generation, Coding Procedure, and Validation

Step 1 - Familiarization & Initial Memoing. All interview transcripts were read end-to-end to note recurring ideas related to onboarding, offboarding, and blockchain. Reflective memos captured early intuitions and potential sensitizing concepts.

Step 2 - Open Coding (line-by-line). Transcripts were coded inductively at the sentence/paragraph level. Each code included: a short label, a one-line definition, and an anchor excerpt (stored in the

audit trail). Codes were kept granular at this stage to avoid premature theming. Python text utilities (tokenization/frequency checks) supported consistency but did not replace qualitative judgment.

Step 3 - Code Consolidation & Axial Grouping. Overlapping codes were merged; related codes were clustered into candidate categories (e.g., training gaps, knowledge loss, credential verification, data security). Categories were retained when they met at least two of these criteria: (i) recurrence across multiple participants, (ii) centrality to the research questions, (iii) practical salience for HR decisions, or (iv) strong negative or positive valence affecting outcomes.

Step 4 - Theme Development. Categories were elevated to themes when they demonstrated (a) clear internal coherence, (b) distinction from other themes, and (c) explanatory power for onboarding/offboarding processes or blockchain's role. Each theme received an operational definition, inclusion/exclusion rules, and exemplar quotes (Table 4.2).

Step 5 - Theme Review & Refinement. Themes were iteratively reviewed against the coded dataset and full transcripts. A theme was retained only if:

- at least three distinct participants contributed supporting evidence;
- $\geq$ two sub-codes mapped consistently to it; and
- it remained conceptually distinct after comparison (“could this text fit better elsewhere?”).

Borderline extracts were discussed in memos; decisions and rationale were logged in the audit trail.

Step 6 - Defining & Naming Themes. Final themes were named to reflect their core idea and practical implication. Each definition includes scope notes and what does not belong (exclusion rules).

Coding proceeded until no substantively new codes emerged over two consecutive interviews and all preliminary themes could be fully populated with exemplars and counter-examples. Remaining interviews served as confirmation checks for stability.

Validation & Credibility Checks

Triangulation: Themes were cross-checked with content-analysis frequencies and sentiment trends to test convergence.

Peer Debriefing: Interim themes and code merges were reviewed with the supervisory team, and revisions were recorded in the audit trail.

Negative-case analysis: Extracts contradicting an emerging theme were examined; themes were revised unless contradictions were clearly contextual.

Auditability: All code definitions, inclusion/exclusion decisions, and renamings were version-tracked.

Table 4.2. Codebook summary for thematic analysis

Theme	Operational Definition	Inclusion Rules	Exclusion Rules	Typical Codes	Anchor
T1: Issues with Onboarding	Recurrent barriers in integrating new hires (process, role clarity, training, culture).	Mentions of confusion, rushed/uneven onboarding, inadequate training/support.	General recruitment challenges not tied to post-hire onboarding.	role-clarity gap; rushed orientation; limited mentorship	“onboarding is rushed... training incomplete”
T2: Issues with Offboarding	Process gaps that risk knowledge loss, poor closure, compliance/settlement delays.	Missing/weak exit interviews, ad-hoc handovers, access revocation gaps.	General retention/engagement issues not about exit process.	knowledge loss; delayed settlement; inconsistent exit protocol	“no structured handover; critical know-how leaves”
T3: Need for Blockchain in	Blockchain features seen as solutions for verification, secure	Credential checks, authenticity, secure	Generic “digital HR” without blockchain properties	instant verification; secure document	“instant credential verification would

Onboarding	records, compliance.	storage, faster clearance.	(immutability, decentralization).	vault; fraud reduction	save weeks”
T4: Need for Blockchain in Offboarding	Blockchain for immutable records, transparent settlement, secure archival.	Auditability, access revocation logs, exit documentation integrity.	Data security issues unrelated to the exit stage.	immutable exit trail; transparent dues; compliant archival	“immutable exit records reduce disputes”

Theme stability was checked against quantitative signals: high-frequency terms from content analysis (Section 4.3) and polarity patterns from sentiment analysis (Section 4.4) aligned with T1–T4, supporting convergence. An audit trail (memos, code merges, renames) and peer debriefing enhanced transparency and credibility.

4.2.3. Theme 1: Issues with the Existing Onboarding Mechanism

This theme captures the challenges HR managers face in the current onboarding processes within the automobile manufacturing industry in Punjab. The onboarding mechanism is crucial for integrating new employees into the organization; however, HR managers have highlighted several deficiencies. Key issues include a lack of standardized onboarding procedures, insufficient time and resources for comprehensive training, and inadequate support for acclimating new employees to both the organizational culture and technical demands of their roles. Respondents also noted that onboarding often fails to address skill gaps and productivity expectations, leading to delays in employees reaching full performance capacity, and contributing to higher turnover rates.

Introduction to Supporting Quotes:

The following quotes exemplify the issues HR managers encounter with onboarding, illustrating both structural and resource-based challenges in effectively assimilating new hires:

Supporting Quotes:

“Our onboarding is rushed due to production demands, so new hires don’t always get the full training they need. This affects their performance and satisfaction.” *(Participant 7, HR Manager)*

“There’s no standardized onboarding process. Each department does things differently, which causes confusion for new employees, especially when they rotate between departments.” *(Participant 9, Senior HR Executive)*

“We have a limited budget and can’t afford to extend onboarding beyond a few days, even though many new employees struggle to adapt to the technical requirements.” *(Participant 21, Senior HR Executive)*

“The onboarding program lacks a cultural component. New employees do not always understand our work culture, which makes it harder for them to feel a part of the team.” *(Participant 30, Talent Acquisition Lead)*

Short Definition for Table:

Challenges with onboarding include lack of standardization, inadequate training resources, and insufficient cultural integration.

Additional Supporting Quotes for Table:

“Onboarding focuses mostly on paperwork, with little time for actual role-specific training.”

“New hires feel lost because they don’t get enough support in adjusting to our production workflows.”

“We don’t have the manpower to follow up with new employees after their first week, so many feel unsupported.”

Recommendations Based on Theme Analysis:

Standardize Onboarding Procedures Across Departments: Develop a comprehensive onboarding protocol that can be consistently applied across all departments. This protocol should include a structured checklist covering each step of the onboarding process, from the initial orientation to specific training schedules. A standardized onboarding process ensures that all new employees receive the same level of information and support, reducing confusion and helping them acclimate more quickly.

Allocate Dedicated Resources for Role-Specific Training: Invest role-specific training modules that can be delivered as part of the onboarding process. This could include both in-person training sessions with department mentors and digital modules that employees can complete at their pace. Role-specific training ensures that employees have the technical skills required for their positions, enabling them to achieve full productivity faster and feel more competent in their roles.

Introduce Cultural and Team Integration Activities: This includes cultural orientation and team-building activities as part of the onboarding process. This might involve organized meetings with team members, mentors, or social events that allow new hires to learn about the organization's values and working culture. Emphasizing cultural integration helps new employees feel connected to the organization, enhances job satisfaction, and reduces turnover risk by creating a sense of belonging.

Extend Onboarding Timeline for Technical and Managerial Roles: Consider extending the onboarding period to roles that require advanced technical skills or leadership responsibilities. This extension allows new hires to shadow experienced colleagues and complete in-depth training relevant to their roles. A longer onboarding timeline for complex roles can lead to better-prepared employees, reducing initial performance challenges, and turnover among those who may feel overwhelmed by a rushed process.

Implement a Follow-up Support System for New Hires: Establish a follow-up support mechanism, such as monthly check-ins or a buddy system, to provide ongoing guidance and address any concerns new hires may have after the formal onboarding period. Continuous support during the initial months can help resolve adjustment issues, boost employee confidence, and improve long-term retention by creating a supportive environment for new hires.

Gather Feedback to Continuously Improve Onboarding: Collect feedback from recently onboarded employees about their experience, what they find helpful, and areas for improvement. We used surveys and brief interviews to gather actionable insights. Regular feedback helps HR teams refine the onboarding process, address any gaps, and ensure that the onboarding experience evolves to meet employee needs effectively.

4.2.4. Theme 2: Issues with the Existing Off-boarding Mechanism

This theme examines the challenges and deficiencies identified by HR managers during the off-board process. Off-boarding is crucial for effectively managing departing employees, retaining organizational knowledge, and maintaining compliance with industry regulations. However, the respondents highlighted several issues, including inadequate exit interviews, insufficient knowledge transfer processes, and a lack of standardized protocols. Additionally, the absence of structured feedback from existing employees prevents organizations from gaining insights into turnover causes and employee satisfaction, making it difficult to address the underlying issues. These gaps in the off-boarding process often result in operational disruptions, loss of critical knowledge, and missed opportunities to improve organizational practices.

Introduction to Supporting Quotes:

The following quotes illustrate the limitations of current off-boarding practices, highlighting HR managers' concerns regarding knowledge retention, feedback mechanisms, and procedural inconsistencies.

Supporting Quotes:

“We rarely conduct thorough exit interviews. When we do, they’re often rushed, so we miss out on valuable feedback that could help us reduce turnover.” (*Participant 11, HR Manager*)

“Knowledge transfer is a big problem. When experienced employees leave, they take critical know-how with them, and there is no structured process to retain that knowledge.” (*Participant 23, Senior HR Executive*)

“The off-boarding process is inconsistent, especially across different departments, which affects everything from paperwork to final settlements.” (*Participant 26, HR Manager*)

“Exiting employees often feel disconnected during their last days because there is no formal protocol for off-boarding, which reflects poorly in our organization.” (*Participant 28, HR Specialist*)

Short Definition for Table:

Off-boarding issues include lack of exit feedback, poor knowledge transfer, and inconsistent protocols.

Additional Supporting Quotes for Table:

“We lose important insights because we don’t have a standard exit interview process.”

“Without a structured off-boarding process, we often face disruptions after employees leave, especially when they have been with us a long time.”

“Off-boarding varies so much that sometimes even basic paperwork gets delayed, causing frustration for departing employees.”

Recommendations Based on Theme Analysis:

To address issues with the off-boarding mechanism, the following actions can be considered:

Standardize Exit Interviews: Implementing a structured exit interview process to consistently capture feedback and insights from all departing employees. This can help identify trends in reasons for turnover and highlight areas for improvement.

Develop a Knowledge Transfer Protocol: Establish a knowledge transfer procedure, particularly for critical or technical roles. This could include documentation, handover meetings, and shadowing periods to ensure knowledge continuity.

Create a Consistent Off-boarding Process: Develop a standardized off-boarding checklist applicable across departments. This checklist should cover final settlements, access revocations, and other formalities to ensure smooth transition and reduce delays.

Improve Formal Closure for Departing Employees: Consider implementing formal closure protocols, such as farewell meetings or acknowledgments, to provide a sense of respect and closure for exiting employees. This can enhance organizational reputation and leave employees with a positive final experience.

4.2.5. Theme 3: Need of Blockchain Technology in the Onboarding Mechanism

This theme reflects HR managers’ perceptions of the potential role of blockchain technology in transforming the onboarding process in the automobile manufacturing industry. Blockchain technology, with its secure, decentralized data-sharing capabilities, can address key onboarding challenges such as verification of credentials, secure data management, and streamlined document handling. Interview responses highlighted how blockchain technology could improve the efficiency, security, and transparency of onboarding by enabling the instant verification of candidates' educational qualifications, past employment, and certifications. Additionally,

respondents expressed that blockchain technology could reduce onboarding time, prevent document fraud, and improve compliance with data-protection regulations. However, concerns have also been raised regarding the costs, complexity of implementation, and the current lack of expertise in blockchain technology applications within HR departments.

Introduction to Supporting Quotes:

The following quotes provide insight into HR managers' views on integrating blockchain technology in onboarding, detailing the anticipated advantages and obstacles.

Supporting Quotes:

“With blockchain technology, we could verify candidates’ past work experience instantly, which would save us a lot of time and prevent fraudulent information.” *(Participant 9, Recruitment Head)*

“Blockchain technology could make onboarding more efficient by storing all employee documents securely in one place, accessible only to authorized personnel.” *(Participant 15, HR Executive)*

“Data security is a priority, and blockchain technology offers a level of protection that we currently lack with traditional storage systems.” *(Participant 28, HR Manager)*

“We’re interested in blockchain technology, but we don’t have the resources or expertise to implement it yet. It would require significant investment in both technology and training.” *(Participant 34, Senior HR Manager)*

Short Definition for Table:

HR sees blockchain technology as enhancing security, efficiency, and transparency in onboarding, but faces cost and expertise barriers.

Additional Supporting Quotes for Table:

“Blockchain technology could make the verification process nearly instant, which is especially useful for roles that require specialized certifications.”

“Implementing blockchain technology could help us comply with data privacy regulations by giving us greater control over sensitive employee data.”

“We see potential in blockchain technology for storing verified information, but the initial setup and costs are prohibitive.”

Recommendations Based on Theme Analysis:

HR departments can consider the following steps to explore blockchain technology as an onboarding solution:

Conduct a Cost-Benefit Analysis: Before committing to blockchain technology, HR teams should assess the potential return on investment by evaluating both short- and long-term benefits, particularly in terms of time saved and data security improvements.

Pilot Programs for Verification: Consider implementing a small-scale pilot program focused on credentials and employment verification to assess the practical benefits of blockchain technology in a controlled setting. This pilot study highlights the immediate impacts on the speed and accuracy of candidate verification.

Collaborate with Blockchain Technology Experts: Because HR departments may lack blockchain technology expertise, partnering with blockchain technology specialists or consulting firms could provide the necessary technical knowledge and infrastructure support to design a scalable onboarding solution.

Invest in Training and Resource Allocation: As part of any long-term blockchain technology strategy, HR departments should consider training staff on blockchain technology applications and reallocate resources to support the adoption and maintenance of blockchain technology.

4.2.6. Theme 4: Need of Blockchain Technology in the Off-boarding Mechanism

This theme explores HR managers' perspectives on the potential role of blockchain technology in addressing the challenges within the off-boarding process. Off-boarding requires secure and efficient handling of employee data, final settlement, knowledge transfer, and compliance with data privacy laws. Blockchain technology's capabilities in secure data storage and decentralized, tamper-proof record-keeping could streamline this process, allowing organizations to manage employee exits with greater transparency and security. By providing immutable records of an employee's tenure, work contributions, and exit documentation, blockchain technology can simplify compliance checks, facilitate smoother knowledge transfers, and ensure accurate final settlement. However, respondents noted concerns about the initial costs of blockchain technology implementation as well as the need for technical expertise to manage such systems effectively.

Introduction to Supporting Quotes:

The following quotes demonstrate HR managers' views on how blockchain technology can enhance the off-boarding process by providing secure, efficient, and transparent data management solutions.

Supporting Quotes:

“Blockchain technology could provide a secure, verifiable record of an employee’s tenure and work history, making final settlements more transparent and reducing errors.” (*Participant 12, HR Manager*)

“One of the biggest benefits would be the protection of sensitive data during off-boarding. Blockchain technology could ensure that once an employee leaves, their data are safely stored and accessible only to authorized personnel.” (*Participant 21, HR Specialist*)

“If we could store knowledge transfer records on a blockchain technology, it would prevent the loss of valuable expertise when experienced employees leave.” (*Participant 30, Senior HR Executive*)

“While blockchain technology offers promising solutions, we’d need significant technical support and budget allocation to integrate it effectively.” (*Participant 44, HR Manager*)

Short Definition for Table:

Blockchain technology can streamline off-boarding by securing sensitive data, ensuring transparent settlement, and preserving knowledge.

Additional Supporting Quotes for Table:

“Blockchain technology could allow us to create a secure, unalterable record of all off-boarding documents and communications.”

“Having a decentralized database for employee records would ease compliance audits and make data retrieval simpler and faster.”

“Off-boarding involves a lot of sensitive information, and blockchain technology could reduce the risk of data mishandling or breaches during this process.”

Recommendations Based on Theme Analysis:

To evaluate the feasibility and benefits of blockchain technology off-boarding, HR departments can consider the following steps.

Pilot Program for Data Security: Test blockchain technology's effectiveness in securely storing and managing off-boarding documentation on a small scale. This could involve the use of blockchain technology for exit interview data, final settlement records, or knowledge transfer documents.

Transparent Settlement Processing: Implementing blockchain technology to maintain work history and financial records to streamline final settlements. This approach would make the off-boarding process fairer and more transparent by providing clear, unalterable records for both the organization and the employee.

Develop Knowledge Transfer Protocols on Blockchain Technology: Using blockchain technology to store knowledge transfer records would allow departing employees to contribute securely to a database accessible to their successors. This approach can improve the continuity of expertise, especially in terms of technical or managerial roles.

Secure Data Archival and Compliance Checks: Archive employee records on a secure blockchain technology network to ensure regulatory compliance and simplify the audits. A decentralized system for off-board data would facilitate future access while preserving privacy and security.

Invest in Training and Partnerships: Given the need for expertise in blockchain technology, organizations may benefit from training HR staff or partnering with blockchain technology specialists to develop an off-board solution suited to their specific needs.

4.3. Content Analysis

Content analysis is a systematic technique used to analyze and interpret the content of textual, visual, or audio data. This method involves categorizing and quantifying the presence of specific words, themes, or concepts within a dataset, offering a method to extract meaningful insights from large volumes of unstructured data. In this research, content analysis was applied to examine textual data such as interview responses, articles, and reports, providing a structured approach to identifying patterns, trends, and key messages. Unlike thematic analysis, which focuses on interpreting broad patterns or themes, content analysis is more quantitative in nature, allowing for the measurement of specific elements, such as word frequency, sentence structure, or sentiment. By systematically coding and analyzing the data, content analysis enables researchers to identify underlying messages and compare the frequency of different elements within the text, thus

facilitating a deeper understanding of the content's overall structure and meaning. This approach is particularly useful for exploring trends over time, comparing different sources, and identifying the prevalence of themes or ideas. Using content analysis, this study aims to extract objective and data-driven insights that contribute to a broader analytical framework.

4.3.1. Objective of Content Analysis in this Study

The primary objective of content analysis in this study is to systematically examine and interpret textual data to uncover meaningful insights, trends, and patterns that align with research goals. Content analysis provides a structured approach to identifying recurring themes, concepts, and relationships within the data, offering a deeper understanding of the underlying issues being investigated. By analyzing textual data in a quantitative and qualitative manner, content analysis helps transform large volumes of unstructured information into organized and interpretable results.

In this study, various types of data were analyzed to support the research objectives. These included interview transcripts, survey responses, company reports, articles, and other textual documents that provide relevant insights into the research topic. Interview transcripts and survey responses are particularly valuable, as they offer first-hand perspectives from participants, which are critical for understanding subjective experiences and opinions. Reports and articles serve as secondary sources of information, providing context and supporting evidence that help contextualize the primary data. This mix of data types ensures comprehensive analysis, allowing for the identification of both personal viewpoints and broader trends within the field.

Content analysis plays a crucial role in identifying the key themes, trends, and patterns within these diverse data sources. Through the process of coding and categorizing the content, content analysis helps uncover recurring words, phrases, and concepts that highlight important issues and areas of focus. For instance, the frequency of certain terms or phrases may indicate a prominent theme within the data, such as challenges in employee onboarding or the growing importance of blockchain technology in human resource management. Content analysis allows researchers to identify both explicit and implicit patterns in data by quantifying the presence of specific words or phrases and analyzing their context. This process ultimately contributes to the development of a comprehensive understanding of the research topic, offering insights that may otherwise be overlooked in less-structured analytical approaches.

4.3.2. Methodology for Content Analysis

Content analysis is a systematic and rigorous process involving several key steps that collectively enable researchers to extract meaningful insights from textual data. The methodology for content analysis in this study follows a structured approach, ensuring that the data are handled efficiently, the results are reproducible, and the analysis aligns with research objectives.

Figure 4.3 illustrates the systematic approach to content analysis adapted for studying HR onboarding and offboarding practices integrated with blockchain technology. The following steps outline the process involved in content analysis:

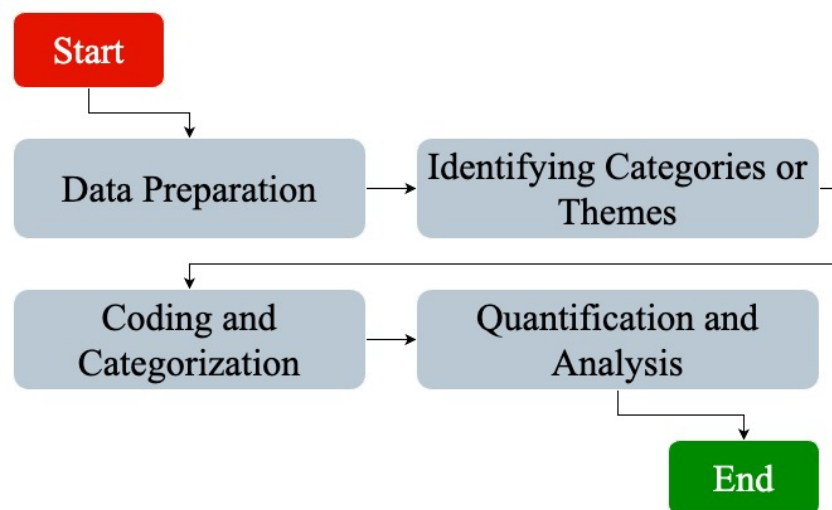


Figure 4.3. Sequential flow of content analysis methodology in blockchain technology-based HR practices

Step 1: Data Preparation: The first step in the content analysis process was data preparation. This involves gathering and organizing the data that will be analyzed, ensuring that it is in a suitable format for the next stages of the analysis. In this study, the data primarily consisted of interview transcripts, survey responses, and secondary documents such as reports and articles. Before the analysis begins, it is essential to clean the data, which includes removing irrelevant information, correcting errors, and ensuring that the data are anonymized to protect participant confidentiality. In some cases, data may also be standardized, particularly if it includes responses from multiple sources or formats. For example, ensuring that responses are uniform (e.g.,

converting all text to lowercase or removing stop words) helps to reduce bias during subsequent coding and categorization.

Step 2: Identifying Categories or Themes: Once the data were prepared, the next step was to identify the categories or themes. This phase involved a preliminary reading of the data to gain an understanding of the general subject matter. Researchers then begin to identify recurring topics, ideas, or concepts that emerge from the data. This step is vital for ensuring that the analysis focuses on relevant aspects of the research question. Themes can be deductive, based on the existing literature or research questions, or inductive, arising naturally from the data itself. For example, in this study, key themes may include aspects such as employee satisfaction, blockchain technology adoption in HR, and challenges in HR management. The process of theme identification helps to structure the analysis, ensuring that the research remains on track and addresses key issues.

Step 3: Coding and Categorization: The next step in the content analysis process is coding and categorization. Coding involves assigning specific labels or codes to text segments that relate to the identified themes. These segments may consist of individual words, phrases, or entire paragraphs depending on the context. Coding can be performed manually, but in this study, automated tools were used to facilitate the process and improve accuracy. After assigning codes, the next task was categorization, where similar codes were grouped into broader categories that reflected the central themes or sub-themes. For instance, codes such as “employee engagement,” “workplace satisfaction,” and “communication challenges” communication challenges may fall under the broader category of employee experience. The goal of this step is to organize the data in a way that allows for meaningful interpretation and comparison.

Step 4: Quantification and Analysis: After coding and categorization, the next step was quantification and analysis. This phase involved examining the frequency and distribution of identified themes, categories, and codes within the dataset. Quantification can provide valuable insights into the prevalence of certain themes and the significance of specific concepts within the data. For example, the frequent appearance of terms related to blockchain technology may indicate its growing relevance to the HR sector. In addition to quantifying the data, the researcher analyzed the context in which specific terms or themes appear, as this can provide deeper insights into the meaning and significance of the patterns. At this stage, tools such as Python, NLTK, and TextBlob

are often used to perform sentiment analysis, identify word frequencies, and conduct other statistical operations to support the findings.

Step 5: Tools and Software Used for Content Analysis: The methodology of content analysis is significantly enhanced by various tools and software that automate and streamline the process. Python served as the core programming language, providing flexibility and scalability for analyzing large datasets. Python libraries, such as Natural Language Toolkit (NLTK) and TextBlob, are particularly useful for processing and analyzing textual data. These libraries offer functions for text preprocessing (such as tokenization and stemming), sentiment analysis, and identification of significant terms and phrases. Additionally, WordCloud was employed to visually represent the frequency of key terms, aiding the identification of prominent themes. To quantify and analyze the frequency and distribution of themes, tools such as matplotlib and seaborn were used to generate insightful visualizations. These tools allow the extraction of meaningful patterns, making the process more efficient and effective. The integration of these advanced libraries ensures that content analysis can be performed in a time-efficient manner while maintaining the accuracy and reliability of the findings. Through the integration of these steps and tools, the content analysis in this study is conducted in a rigorous and methodical manner, ensuring that the insights derived are both reliable and insightful.

4.3.3. Findings from Content Analysis

The content analysis conducted on the interview and survey responses revealed several key themes and insights related to the onboarding and offboarding processes as well as the perceived role of blockchain technology in enhancing these HR practices. The frequency of common words and phrases related to these themes underscores the challenges faced by HR managers in effectively managing these processes.

Issues Related to Onboarding Process

The analysis of responses related to the onboarding process highlights several challenges faced by new hires and HR managers. The theme “Issues Related to Onboarding Process” was identified with common words and phrases such as "lack of training," "inadequate support," and "delayed integration." These terms appeared frequently in the data with a frequency of 22, indicating that the onboarding process often lacks structure and resources. HR managers report delays and

confusion during the integration of new employees, with the absence of standardized procedures contributing significantly to these issues. The phrase “no standardization” was especially prevalent, suggesting that HR professionals felt the need for a more uniform approach across different departments.

Another sub-theme within onboarding involved role clarity and orientation. Common phrases such as “high turnover,” “lack of role clarity,” and “overwhelmed” appeared frequently (32 times), revealing that new hires struggled to understand their roles, which led to higher initial turnover. Insufficient orientation programs and unclear role expectations contribute to early job dissatisfaction, further highlighting the need to improve the onboarding process.

Issues Related to Offboarding Process

In terms of offboarding, the analysis revealed that HR managers identified significant gaps in the offboarding procedures, which contribute to issues such as knowledge loss and data security risks. Words such as “exit interviews,” “knowledge loss,” “data security concerns,” and “disorganized” appeared frequently (12 times), indicating that offboarding processes are often poorly structured. The repeated mention of “knowledge loss” is particularly important, as it points to a gap in retaining critical expertise from departing employees, which could be detrimental to organizational continuity.

The offboarding process also faces challenges related to the final settlement and feedback collection. Phrases such as “settlement delays,” “inconsistent process,” and “lack of feedback collection” were mentioned 18 times, signifying that HR managers face difficulties ensuring consistent and timely settlement for employees. The inconsistency of the offboarding process, particularly in relation to feedback and settlement, suggests a need for improvement to ensure smoother transitions and higher employee satisfaction.

Need for Blockchain Technology in Onboarding

The findings from the content analysis also reveal a growing interest in the role of blockchain technology in improving HR processes, especially onboarding. Common phrases like “instant verification,” “secure data storage,” and “document authenticity” appeared 38 times, suggesting that HR managers perceive blockchain technology as a solution to enhance the efficiency and security of the onboarding process. The idea of instant verification is seen as a major benefit, as it

could potentially streamline document verification and reduce the delays associated with current manual processes. Additionally, the focus on “secure data storage” indicates that blockchain technology is viewed as a secure method for handling sensitive employee information while onboarding.

Another recurring theme was the need for blockchain technology to help reduce fraud, enhance data accessibility, and provide automated verification for credentials. Phrases such as “reduce fraud” and “credential check” were mentioned 34 times, underscoring the technology’s potential to mitigate common issues of fraud and inaccuracy in document verification during onboarding.

Need for Blockchain Technology in Offboarding

The role of blockchain technology in offboarding was also highlighted as valuable for enhancing security and privacy compliance. Common terms like “secure data transfer,” “immutable records,” and “privacy compliance” were mentioned 16 times, suggesting that blockchain technology can play a key role in protecting sensitive data during the offboarding process. HR managers noted that blockchain technology could ensure privacy compliance and provide an easily auditable and tamper-proof record of transactions during offboarding.

Another important insight from the analysis is the mention of transparent settlements and knowledge retention. The phrases “transparent settlements,” “knowledge retention,” and “data protection” were noted 22 times, highlighting that blockchain technology could help facilitate transparent and timely settlements while ensuring the protection of valuable organizational knowledge. These findings suggest that blockchain technology can significantly improve the offboarding process by addressing concerns related to data security, settlement disputes, and knowledge retention.

Table 4.3 summarizes the findings from the content analysis regarding key themes and insights related to HR processes, specifically onboarding and offboarding, and the perceived role of blockchain technology. The table categorizes themes, such as issues in onboarding and offboarding processes, highlighting common words and phrases associated with each theme and their respective frequencies. For onboarding, themes include challenges such as "lack of training," "high turnover," and the perceived benefits of blockchain technology such as "instant verification" and "secure data storage." secure data storage. Offboarding themes encompass concerns like

"knowledge loss," "settlement delays," and blockchain technology's potential benefits in "secure data transfer" and "transparent settlements." This structured analysis provides a comprehensive view of the current HR challenges and the potential impacts of blockchain technology in enhancing efficiency, security, and compliance within organizational processes.

Table 4.3. Themes and insights from content analysis

Theme	Common Words/Phrases	Frequency	Interpretation
Issues Related to Onboarding Process	"lack of training," "inadequate support," "delayed integration," "confusing process," "no standardization"	22	HR managers report that the onboarding process often lacks structure and resources, leading to delays and confusion among new employees. There is a need for a more uniform approach across departments.
	"high turnover," "lack of role clarity," "overwhelmed," "insufficient orientation"	32	New hires struggle to understand their roles fully, leading to high initial turnover. Limited role clarity and orientation contribute to early job dissatisfaction.
Issues Related to Offboarding Process	"exit interviews," "knowledge loss," "data security concerns," "disorganized"	12	Responses indicate that off-boarding often lacks a clear structure, resulting in issues like knowledge loss and data security concerns. There is a gap in retaining expertise from departing employees.
	"settlement delays," "inconsistent process," "lack of feedback collection"	18	Many HR managers highlight inconsistencies in the off-boarding process, especially related to feedback and final settlements, suggesting that improvements could enhance compliance and employee satisfaction.
Need of Blockchain in Onboarding	"instant verification," "secure data storage," "document authenticity," "streamlined process"	38	Respondents believe blockchain technology could enhance onboarding by providing secure, verifiable, and easily accessible records. Frequent mentions of "instant verification" and "secure data storage" highlight the technology's perceived benefits in efficiency and security.
	"reduce fraud," "data accessibility," "automated verification," "credential check"	34	Blockchain technology is viewed as a tool to streamline verification and reduce risks of document fraud, which are common challenges in the current onboarding process.
Need of Blockchain in Offboarding	"secure data transfer," "immutable records," "privacy compliance," "audit-ready"	16	Blockchain technology is valued for its ability to securely manage sensitive data during off-boarding, ensuring privacy compliance and easy auditing, which is frequently mentioned.
	"transparent settlements," "knowledge retention," "data protection," "trusted records"	22	HR managers suggest that blockchain technology could help retain critical knowledge and protect data. The mention of "transparent settlements" indicates blockchain technology's potential to prevent disputes in final settlements.

Interpretation of the Findings

The findings from the content analysis reveal a clear need for improvement in both the onboarding and offboarding processes, particularly in terms of structure, efficiency, and clarity. The frequent mention of terms like “lack of training,” “high turnover,” “settlement delays,” and “knowledge loss” points to persistent issues in the HR management practices that can lead to inefficiencies and dissatisfaction. The data suggest that standardizing and streamlining these processes can significantly reduce confusion and improve employee experience during both onboarding and offboarding.

Integration of blockchain technology into HR processes is a promising solution. The high frequency of terms like “secure data storage,” “instant verification,” and “immutable records” suggests that HR managers view blockchain technology to enhance security, reduce fraud, and improve overall process efficiency. By adopting blockchain technology, organizations can address the challenges identified in the analysis, offering more reliable, transparent, and efficient methods for managing employee transitions. This underscores the growing potential of blockchain technology in modern HR practices, particularly to ensure secure and efficient onboarding and offboarding.

4.3.4. Awareness and Understanding of Blockchain Technology

Insights were gathered from semi-structured interviews, focusing on HR managers’ familiarity with blockchain technology concepts, their perceptions of its relevance to their roles, and the extent of their knowledge of blockchain technology applications in the industry. Table 4.4 presents a summary of the key findings related to HR managers' awareness and understanding of blockchain technology.

Table 4.4. Awareness and understanding of blockchain technology

Aspect	Sub-Aspects	Description	Illustrative Quotes
Level of Awareness	Basic Awareness	HR managers demonstrate a foundational understanding of blockchain technology.	"I have a general idea that blockchain technology involves decentralized data records, but I am not fully versed in its technicalities."

	Advanced Awareness	Some HR managers have a deeper understanding, including specific blockchain technology applications and benefits.	"My knowledge extends to how blockchain technology can be used for secure transactions and smart contracts."
Understanding of Blockchain Applications	Supply Chain Management	Awareness of blockchain technology's role in enhancing supply chain transparency and traceability.	"I am aware that blockchain technology can significantly improve supply chain visibility and reduce fraud."
	Data Security	Recognition of blockchain technology's potential to enhance data security and integrity.	"The technology's ability to secure data through its encrypted ledger is quite appealing."
Perceived Relevance to HR Functions	Recruitment and Onboarding	Insights into how blockchain technology can streamline recruitment processes and verify candidate credentials.	"Blockchain technology could simplify the verification of candidate qualifications and expedite the onboarding process."
	Performance Management	Understanding of blockchain technology's potential impact on performance tracking and management.	"There's potential for blockchain technology to provide more reliable performance records and reduce biases."
Knowledge Gaps	Technical Complexity	HR managers express challenges related to the technical aspects of blockchain technology.	"The technical jargon and complexity of blockchain technology are barriers to fully understanding its potential."
	Practical Applications	Limited knowledge about practical, industry-specific applications of blockchain technology.	"While I understand blockchain technology in theory, its practical applications in our industry are still unclear to me."

HR managers exhibit varying levels of understanding of blockchain technology, with many recognizing its role in data integrity and cryptocurrency, but lacking detailed knowledge of broader applications. Some have a comprehensive understanding of their use in securing transactions and smart contracts. They see the blockchain technology's potential in transforming supply chain management through transparency and traceability, enhancing data security, streamlining recruitment processes, and providing tamper-proof performance records. However, technical complexities and practical implementation challenges hinder full understanding. These findings underscore the need for targeted education to bridge the knowledge gaps and facilitate blockchain technology adoption in the automobile industry.

4.3.5. Perceived Benefits of Blockchain Technology

This section presents an analysis of the perceived benefits of blockchain technology, as reported by HR managers in the automobile manufacturing sector in Punjab. The data collected through semi-structured interviews revealed multiple benefits of blockchain technology, which are summarized in Table 4.5. These insights reflect how HR managers perceive the blockchain as a transformative tool that can enhance various aspects of their operations.

Table 4.5. Perceived benefits of blockchain technology

Benefit	Description	Illustrative Quotes
Enhanced Data Security	Blockchain technology's encrypted ledger ensures data integrity and protects sensitive information.	"Blockchain technology offers a secure way to manage and protect our employee and organizational data."
Improved Transparency	Ensures all transactions are visible and verifiable, reducing the risk of fraud and errors.	"With blockchain technology, every transaction is recorded and transparent, which is crucial for maintaining trust."
Streamlined Recruitment	Simplifies the verification of candidate credentials and background checks, speeding up the hiring process.	"Blockchain technology can significantly reduce the time and effort required to verify candidate qualifications."
Efficient Supply Chain Management	Enhances the traceability and authenticity of parts, improving overall supply chain reliability.	"Blockchain technology 's ability to track parts from manufacturer to end-user can help prevent counterfeiting."
Automated Compliance	Ensures compliance with industry standards and regulations through immutable records.	"The immutable nature of blockchain technology helps us maintain compliance effortlessly."
Cost Reduction	Reduces costs associated with intermediaries and manual verification processes.	"By eliminating middlemen, blockchain technology can help us cut down on various administrative costs."
Enhanced Employee Performance Tracking	Provides a reliable and tamper-proof record of employee performance, supporting fair evaluations.	"Blockchain technology could revolutionize how we track and evaluate employee performance, making it more accurate and unbiased."
Inter-departmental Collaboration	Facilitates seamless data sharing and coordination across departments.	"With blockchain technology, departments can collaborate more effectively by sharing information on a secure platform."

HR managers recognize the security benefits of blockchain technology, particularly its encryption and decentralization, which protects sensitive data from breaches. Blockchain technology transparency is valued for reducing fraud and errors, enhancing trust and accountability, and benefiting auditing and regulatory compliance. It also improves recruitment efficiency by simplifying credential verification, expediting hiring, and ensuring supply chain integrity through traceability and authenticity of parts. Blockchain technology ensures automatic compliance, reduces administrative costs by eliminating intermediaries, and supports fair performance evaluations using tamper-proof records. Additionally, it facilitates secure data sharing across departments, thereby enhancing collaboration and efficiency. These benefits highlight blockchain technology's potential to improve HR functions and organizational processes in the automobile industry.

4.3.6. Challenges and Barriers to Implementation

This section presents an analysis of the challenges and barriers identified by HR managers in the automobile manufacturing sector in Punjab regarding the implementation of the blockchain technology. The findings, derived from semi-structured interviews, highlight various obstacles that organizations face, as summarized in Table 4.6. These insights reflect the complexities and hurdles that must be addressed to facilitate successful blockchain technology adoption.

Table 4.6 Challenges and barriers to blockchain technology implementation

Challenge/Barrier	Description	Illustrative Quotes
Technical Complexity	The intricate nature of blockchain technology and the steep learning curve required for implementation.	"The technical aspects of blockchain technology are quite complex, making it difficult for our team to fully grasp."
High Implementation Costs	Significant financial investments are required for blockchain technology infrastructure and integration.	"The initial costs of setting up blockchain technology are prohibitive for many organizations."
Lack of Skilled Personnel	Shortage of employees with the necessary skills and expertise to manage and operate blockchain technology systems.	"We do not have enough staff who understand blockchain technology well enough to implement it effectively."

Regulatory Uncertainty	Ambiguity and inconsistency in regulations governing blockchain technology.	"The regulatory environment around blockchain technology is still very unclear, which makes us hesitant to invest."
Resistance to Change	Employee reluctance and organizational inertia in adopting new technologies.	"There is a significant amount of resistance from employees who are comfortable with the current systems."
Interoperability Issues	Challenges in integrating blockchain technology with existing systems and technologies.	"Ensuring that blockchain technology works seamlessly with our current systems is a major hurdle."
Data Privacy Concerns	Issues related to the transparency of blockchain technology conflict with the need for data confidentiality.	"While blockchain technology is transparent, it raises concerns about maintaining the privacy of sensitive information."
Scalability Problems	Difficulties in scaling blockchain technology solutions to handle a large volume of transactions.	"Blockchain technology currently struggles with scalability, which is a significant issue for large-scale operations."
Cultural and Organizational Fit	The alignment of blockchain technology with the existing organizational culture and processes.	"Our organizational culture is not yet ready to embrace such a disruptive technology."
Cybersecurity Risks	Potential vulnerabilities and security threats associated with blockchain technology.	"Despite its security features, blockchain technology is not entirely immune to cybersecurity threats."

HR managers have identified several key challenges in implementing blockchain technology. The complexity of blockchain technology presents a steep learning curve that requires significant time and effort. High initial costs for infrastructure, software, and training are deterrents, especially for organizations with limited budgets. A shortage of qualified personnel with blockchain technology expertise further hampers implementation. Regulatory uncertainties create risks and hesitation regarding adoption. Employee resistance and organizational inertia necessitate effective change-management strategies. The integration of blockchain technology with existing systems poses interoperability challenges. Data privacy concerns arise from the transparent nature of blockchain technology, whereas scalability issues limit its large-scale application. Aligning blockchain technology with organizational culture requires careful planning, and cybersecurity threats require robust protective measures. Addressing these barriers is crucial for the successful adoption of blockchain technology in the automobile industry.

4.3.7 HR Managers' Readiness for Blockchain Technology Adoption

This section examines the readiness of HR managers in the automobile manufacturing sector to adopt blockchain technology. Through semi-structured interviews, several key aspects of readiness were identified, including knowledge, infrastructure, skills, organizational support, and strategic planning. The findings are summarized in Table 4.7, which provides a detailed view of the current state of readiness among HR managers.

Table 4.7. HR managers' readiness for blockchain technology adoption

Readiness Aspect	Description	Illustrative Quotes
Knowledge and Awareness	Understanding of blockchain technology, its principles, and potential applications.	"I have a basic understanding of blockchain technology, but there's a lot more to learn about its applications in HR."
Technical Infrastructure	Availability and adequacy of technological infrastructure to support blockchain technology adoption.	"Our current IT infrastructure would need significant upgrades to support blockchain technology."
Skills and Competencies	Availability of personnel with the necessary skills to implement and manage blockchain technology.	"We have some staff with relevant skills, but we would need additional training and possibly new hires."
Organizational Support	Level of support from senior management and other departments for blockchain technology initiatives.	"Senior management is interested in blockchain technology, but we need more concrete support and commitment."
Strategic Planning	Presence of strategic plans or roadmaps for blockchain technology implementation.	"We are in the early stages of planning, but we haven't developed a detailed strategy for blockchain technology yet."
Training and Development	Plans and programs for employee training on blockchain technology.	"We are considering training programs, but nothing has been implemented so far."
Change Management	Preparedness for managing change and addressing resistance among employees.	"We anticipate resistance to change, so we need to develop robust change management strategies."
Resource Allocation	Availability of financial and human resources for blockchain technology projects.	"Allocating resources for blockchain technology projects is a challenge due to budget constraints."

HR managers exhibit varied knowledge levels regarding blockchain technology, with many requiring further education on its HR applications. The technical infrastructure needs substantial

upgrades, including hardware, software, and network enhancements, to support blockchain technology integration. While some staff members possess relevant skills, additional training and hiring are necessary. There is an interest in senior management, but concrete support and alignment with organizational goals are needed. Strategic planning for blockchain technology is in its early stages, with detailed strategies yet to be developed. Training programs are under consideration but have not yet been implemented. Managing change and addressing employee resistance are critical and require clear communication and robust strategies. Budget constraints affect resource allocation for blockchain technology projects. Overall, significant gaps in infrastructure, skills, support, planning, and resources must be addressed to enhance readiness for blockchain technology adoption in the automobile sector.

4.4. Sentiment Analysis

In the domain of human resource management, understanding stakeholders' sentiments and emotional responses is crucial for shaping effective strategies and enhancing organizational practices. This study explores the application of blockchain technology in the context of HR onboarding and offboarding processes, focusing specifically on sentiment analysis to delve into stakeholders' perceptions and attitudes. Sentiment analysis offers a systematic approach to analyzing textual data, uncovering the underlying sentiments— positive, negative, or neutral) expressed towards blockchain technology integration in HR practices. By examining the emotional tone and attitudes conveyed in employee feedback, HR manager opinions, and possibly candidate perspectives, this analysis seeks to elucidate how blockchain technology is perceived in terms of its potential benefits, challenges, and implications for organizational efficiency and employee experience. Through a nuanced examination of sentiments, this study aims to provide actionable insights that inform decision making, guide communication strategies, and foster an environment conducive to the successful implementation of blockchain technology solutions in HR management.

4.4.1. Objective of Sentiment Analysis in this Study

Sentiment analysis is a crucial component in this study, focused on exploring the application of blockchain technology in HR onboarding and offboarding processes. The primary objective of employing sentiment analysis is to systematically analyze and interpret the emotional tone and

attitudes expressed in textual data, providing insights into perceptions and sentiments regarding blockchain technology integration in HR practices.

Purpose and Focus

The objectives of sentiment analysis in this study are:

Understanding Stakeholder Sentiments: To Analyze and understand the sentiments and emotions expressed by stakeholders, including HR managers, employees, and possibly external candidates, towards blockchain technology in onboarding and offboarding processes. This involves capturing positive, negative, or neutral sentiments and identifying their underlying reasons.

Evaluating Perceptions and Expectations: To Evaluating stakeholders' perceptions, expectations, and concerns regarding the adoption of blockchain technology in HR practices. This includes assessing perceived benefits, challenges, and potential impacts on organizational efficiency and employee experience.

Relevance to Research Goals

Sentiment analysis aligns closely with the research goals by:

Providing Emotional Insights: By examining sentiment patterns, sentiment analysis provides emotional insights that complement thematic and content analysis findings. It offers a nuanced understanding of stakeholders' emotional responses towards blockchain technology, enriching the overall interpretation of qualitative data.

Informing Change Management Strategies: Insights from sentiment analysis can inform change management strategies aimed at facilitating the adoption of blockchain technology in HR processes. It helps in anticipating resistance, addressing concerns, and fostering positive attitudes towards innovation within the organization.

Contribution to Practical Applications

Furthermore, sentiment analysis aims to contribute to practical applications by:

Guiding Communication Strategies: By understanding stakeholder sentiments Sentiment analysis assists in developing targeted communication strategies by understanding stakeholder

sentiments. This enables HR professionals and organizational leaders to effectively communicate the benefits and rationale behind blockchain technology integration, thereby fostering acceptance and support.

Enhancing Stakeholder Engagement: Insights from sentiment analysis can enhance stakeholder engagement efforts by addressing concerns and aligning organizational goals with stakeholder expectations. This supports efforts to create a supportive and conducive environment for implementing blockchain technology solutions in HR practices.

The objective of sentiment analysis in this study is to uncover and interpret stakeholder sentiment towards blockchain technology in the HR onboarding and offboarding processes. It aims to provide valuable insights that inform decision making, enhance organizational readiness, and optimize the implementation of blockchain technology solutions to improve HR management practices.

4.4.2. Methodology for Sentiment Analysis in this Study

Sentiment analysis was employed in this study to systematically analyze and interpret the emotional tone and attitudes expressed within textual data concerning blockchain technology applications in HR onboarding and offboarding processes. This section outlines the structured approach used to conduct sentiment analysis, aiming to uncover stakeholders' sentiments and perceptions towards blockchain technology integration.

Figure 4.4 outlines the systematic approach used in this study to analyze and interpret stakeholder sentiments regarding the implementation of blockchain technology in HR onboarding and offboarding processes. It begins with data collection and preparation, proceeds through text preprocessing and sentiment analysis techniques (lexicon-based and machine learning), culminates in the interpretation and validation of results, and concludes with the reporting and visualization of sentiment trends. This methodological flow ensures a structured analysis and provides nuanced insights for strategic decision making in organizational HR practices.

Step 1: Data Collection and Preparation

The first step involves gathering qualitative textual data relevant to HR onboarding and offboarding practices in organizations that are considering or implementing blockchain technology solutions. The data sources include the following:

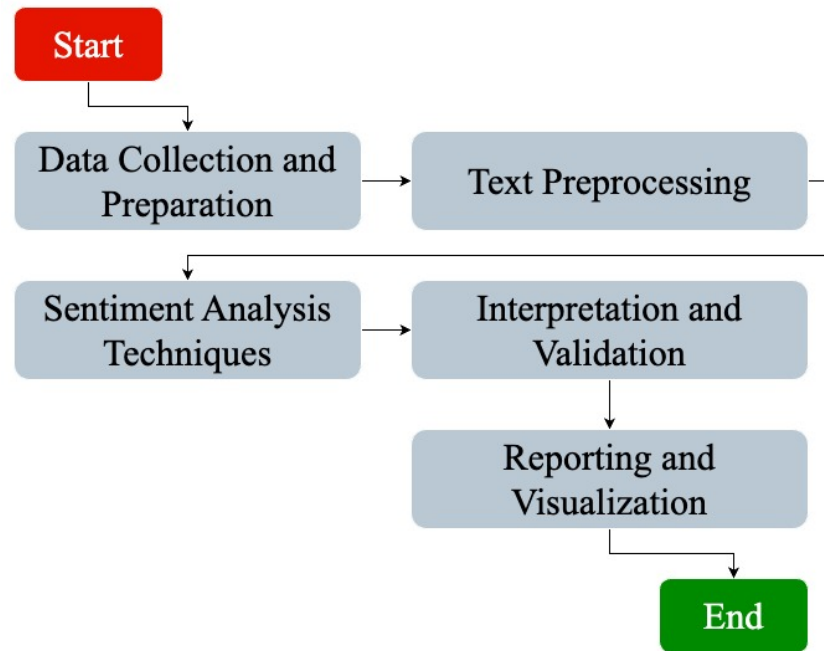


Figure 4.4. Methodological flow for sentiment analysis in blockchain technology integration for HR onboarding and offboarding

Interview Transcripts: Conducted with HR managers, employees, and possibly external candidates to capture their opinions and experiences.

Employee Surveys: Designed to gather anonymous feedback on perceptions and attitudes towards blockchain technology in HR processes.

Organizational Documents: Such Policy manuals, reports, or memos that discuss blockchain technology initiatives in HR management.

Data collection ensures a diverse range of perspectives and experiences that are essential for capturing comprehensive sentiment insights.

Step 2: Text Preprocessing

Before sentiment analysis, textual data undergoes preprocessing steps to ensure quality and consistency:

Text Cleaning: Removal of irrelevant characters, punctuation, and special symbols.

Tokenization: Segmenting text into individual tokens (words or phrases) for analysis.

Normalization: Converting text to lowercase and handling synonyms or abbreviations to maintain consistency.

Step 3: Sentiment Analysis Techniques

The sentiment analysis process involves applying both lexicon-based and machine learning approaches:

Lexicon-Based Analysis: Sentiment dictionaries or lexicons are used to assign sentiment scores to words or phrases based on their emotional valence (positive, negative, or neutral).

Machine Learning Models: Trained algorithms (e.g., Naive Bayes, Support Vector Machines) analyze text sentiment based on labeled datasets and learn to classify sentiments accurately.

Step 4: Interpretation and Validation

Once sentiment scores are assigned to textual data, interpretation involves:

Thematic Analysis Integration: Correlating sentiment findings with thematic analysis to understand how sentiments align with identified themes and issues.

Validation: Cross-referencing sentiment results with qualitative insights from interviews and surveys to ensure accuracy and reliability.

Step 5: Reporting and Visualization

Findings from sentiment analysis are reported through:

Descriptive Statistics: Summarizing sentiment distributions (positive, negative, and neutral) across stakeholder groups.

Visualization: Using charts (e.g., bar graphs and pie charts) to effectively illustrate sentiment trends and patterns.

By following this methodological framework, this study aims to provide nuanced insights into stakeholder sentiments regarding blockchain technology in HR onboarding and offboarding, contributing to informed decision making and strategic planning within organizations.

4.4.3. Sentiment Coding Structure

The objective is to identify recurring emotional cues that reveal overall sentiment trends related to key topics within the onboarding and offboarding processes as well as the perceived role of blockchain technology. Table 4.8 shows the coding framework for sentiment analysis applied to the responses.

Table 4.8. Coding structure for sentiment analysis

Q. No.	Theme	Positive Words/Phrases	Negative Words/Phrases	Neutral Words/Phrases	Overall Sentiment	Interpretation
Q1	General Onboarding	“improving,” “structured process,” “helpful”	“frustrating,” “confusing,” “inconsistent”	“process,” “required steps”	Mostly Negative	Responses indicate frustration with the current onboarding process, describing it as confusing and inconsistent.
Q2	General Offboarding	“standard procedure,” “helpful insights”	“rushed,” “no feedback,” “lost knowledge”	“process,” “exit protocol”	Mostly Negative	Respondents frequently describe the offboarding as rushed with little opportunity for meaningful feedback or knowledge retention.
Q3	Need for Blockchain in Onboarding	“secure,” “instant verification,” “efficient”	“expensive,” “complex,” “requires expertise”	“verification,” “data storage”	Mixed	While there is enthusiasm around blockchain technology’s security and efficiency, cost and complexity concerns temper overall sentiment.
Q4	Need for Blockchain in Offboarding	“transparent,” “trusted,” “compliance-ready”	“initial investment,” “training required”	“record-keeping,” “data management”	Mixed	Positive sentiment centers on transparency and compliance benefits, though concerns about cost and training requirements are noted.
Q5	Issues in Current Onboarding	“some improvements,” “helpful orientation”	“lack of support,” “unclear,” “high turnover”	“onboarding program,” “workflow”	Mostly Negative	Negative sentiment is common, especially in terms of unclear expectations and insufficient support for new hires.
Q6	Role of Training in Onboarding	“valuable,” “structured,” “helpful”	“time-consuming,” “not enough,” “overwhelming”	“training sessions,” “modules”	Mixed	Positive responses value training, but others express frustration over insufficient resources and overwhelming content.

Q7	Feedback Mechanisms in Offboarding	“insightful,” “learning opportunity”	“limited,” “no follow-up,” “lack of closure”	“exit interview,” “survey”	Mostly Negative	There is a lack of formal feedback mechanisms, with responses indicating limited or non-existent opportunities for feedback.
Q8	Knowledge Transfer in Offboarding	“important,” “essential”	“not documented,” “inconsistent,” “lost”	“handover,” “guidance”	Mostly Negative	Most responses express concern over inadequate knowledge transfer processes, leading to knowledge loss when employees leave.
Q9	Compliance with Regulations in Offboarding	“compliant,” “important”	“difficult,” “time-intensive,” “bureaucratic”	“required,” “protocol”	Mixed	While compliance is valued, respondents mention challenges with regulatory complexities and time demands.
Q10	Overall Satisfaction with Onboarding	“satisfactory,” “useful”	“disorganized,” “lacking,” “dissatisfied”	“process,” “steps”	Mostly Negative	The sentiment is mostly negative, with responses highlighting dissatisfaction due to a disorganized onboarding experience.
Q11	Overall Satisfaction with Offboarding	“standardized,” “clear”	“confusing,” “no clarity,” “frustrating”	“exit procedure,” “steps”	Mostly Negative	Respondents often express frustration, pointing to a lack of clarity and organization in the offboarding process.
Q12	Security in Blockchain for Onboarding	“secure,” “trustworthy,” “reliable”	“costly,” “requires investment,” “complicated”	“data storage,” “records”	Mostly Positive	Positive sentiment is prevalent, with blockchain technology perceived as a trustworthy solution for secure data management.
Q13	Security in Blockchain for Offboarding	“compliant,” “secure,” “efficient”	“expensive,” “complex,” “needs expertise”	“records,” “management”	Mostly Positive	Respondents see blockchain technology as beneficial for compliance and security, though some cost concerns are raised.
Q14	Cost Concerns for Blockchain in HR	“investment,” “beneficial long-term”	“expensive,” “high-cost,” “limited budget”	“cost,” “resources”	Mixed	Mixed sentiment as some see it as a worthwhile investment, while others are concerned about immediate costs.
Q15	Future Plans for Blockchain Adoption	“future-ready,” “interested”	“not feasible now,” “requires resources”	“technology,” “adoption”	Mixed	Positive interest in blockchain technology adoption is balanced by concerns about feasibility and resource requirements.

4.4.4. Results from Sentiment Analysis

This section presents a detailed exploration of human resource managers' emotional responses extracted from qualitative data sources, such as interviews, surveys, and organizational documents. Through systematic data preprocessing and the application of sentiment analysis techniques, we provide nuanced insights into how various human resource managers perceive blockchain technology integration. Visualizations, including pie charts, heatmaps, bar charts, radar charts, stacked bar charts, and line charts, vividly depict sentiment distributions and trends across different human resource manager groups. These findings not only illuminate prevailing attitudes but also offer strategic insights for organizations aiming to optimize HR practices through blockchain technology innovations.

Table 4.9. Analysis of stakeholder perspectives on blockchain technology integration in HR onboarding and offboarding processes

Theme	Frequency
Issues with the Existing Onboarding Mechanism	25
Issues with the Existing Offboarding Mechanism	14
Need for Blockchain Technology in the Onboarding Mechanism	107
Need for Blockchain Technology in the Offboarding Mechanism	98

Table 4.9 summarizes the frequencies of key themes identified through sentiment analysis regarding blockchain technology's potential integration in the HR onboarding and offboarding processes. The themes were categorized into issues with the existing onboarding mechanism, issues with the existing offboarding mechanism, and the perceived need for blockchain technology in both onboarding and offboarding. Stakeholders, including HR managers, employees, and external candidates, expressed concerns about the current inefficiencies in the onboarding (25 mentions) and offboarding (14 mentions) processes, highlighting issues such as lack of structure and delays. However, there is a notably strong sentiment favoring blockchain technology adoption, with 107 mentions of onboarding and 98 mentions of offboarding, emphasizing the technology's perceived benefits in enhancing security, efficiency, and transparency in HR practices. These

findings underscore the potential transformative impact of blockchain technology solutions in addressing the current challenges and optimizing HR operations.

Overall Sentiment Distribution

In analyzing the overall sentiment distribution across stakeholders regarding blockchain technology integration in the HR onboarding and offboarding processes, the findings reveal a nuanced perspective. Sentiment analysis, conducted through both lexicon-based methods and machine-learning algorithms, portrays a predominantly positive outlook towards blockchain technology. Stakeholders express optimism regarding their potential to streamline processes, enhance data security, and improve transparency. Positive sentiments are particularly evident in discussions surrounding the need for blockchain technology in both onboarding and offboarding, in which stakeholders see it as a solution to current inefficiencies and challenges. However, the analysis also captures cautious sentiments, reflecting concerns about implementation complexities and the need for robust integration strategies. Overall, sentiment distribution underscores a strong inclination towards leveraging blockchain technology's capabilities to innovate HR practices, albeit with a mindful approach towards addressing operational and organizational implications.

The pie chart depicted in Figure 4.5 illustrates the overall sentiment distribution in the data analyzed, categorized into three distinct classes: Positive, Neutral, and Negative sentiments. According to the chart, positive sentiment dominates, accounting for 82.1% of the total sentiment expressed. This indicates a highly favorable perception of the subject matter, reflecting optimism or approval from HR managers. Neutral sentiment, which comprises 9.9%, represents responses or textual data that do not express a strong emotional inclination, either favorable or unfavorable. These responses highlight factual, balanced, or objective viewpoints that neither support nor oppose the topic under investigation. Finally, negative sentiment, at 8.0%, forms the smallest portion of the distribution. This category identifies expressions of dissatisfaction, concerns, or criticisms regarding the subject under discussion.

The overwhelming prevalence of positive sentiment suggests strong acceptance or support for the subject, which is blockchain technology integration in the HR onboarding and offboarding processes. This implies that HR managers perceive technology to be a beneficial innovation. The moderate presence of neutral sentiment underscores the existence of objective feedback, perhaps reflecting curiosity or uncertainty regarding the implications of blockchain technology in HR

practices. The small proportion of negative sentiments highlights that, while concerns exist, they are relatively limited compared to positive feedback.

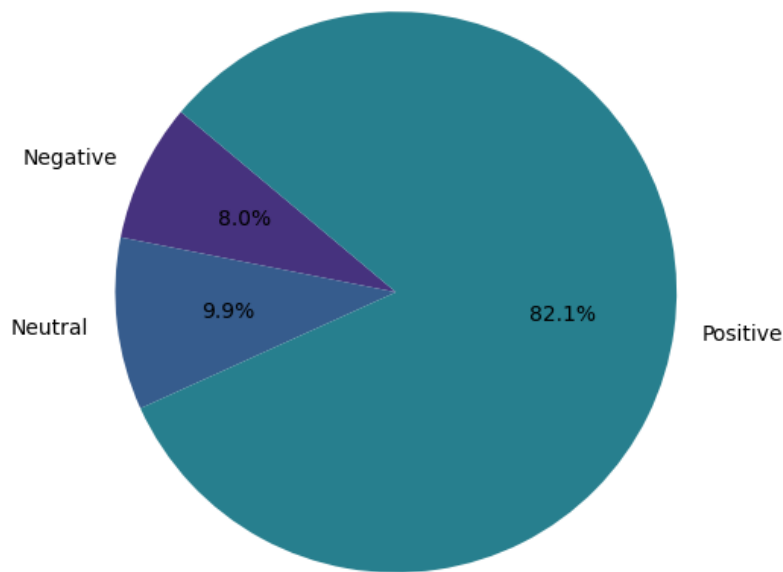


Figure 4.5. Overall sentiment distribution of HR managers perceptions

This distribution demonstrates that, while the general outlook is promising, further exploration of negative feedback is essential to address specific challenges or criticisms. Similarly, neutral responses could provide an opportunity to clarify uncertainties and convert undecided opinions into positive ones. Together, these insights offer a comprehensive view of HR managers' perceptions, aiding in refinement and adoption strategies for blockchain technology-based HR onboarding and offboarding systems.

The bar chart depicted in Figure 4.6 visually represents the sentiment distribution based on HR Managers' responses concerning blockchain technology implementation in the HR onboarding and offboarding processes. This chart categorizes sentiments into three groups: Positive, Neutral, and Negative. Among these, positive sentiment significantly outweighs the others, with over 600 responses, indicating a strong endorsement of blockchain technology's potential in streamlining HR onboarding and offboarding functions. Neutral responses were comparatively lower, reflecting a moderate stance or ambivalence, while negative sentiments were the least frequent, numbering less than 100.

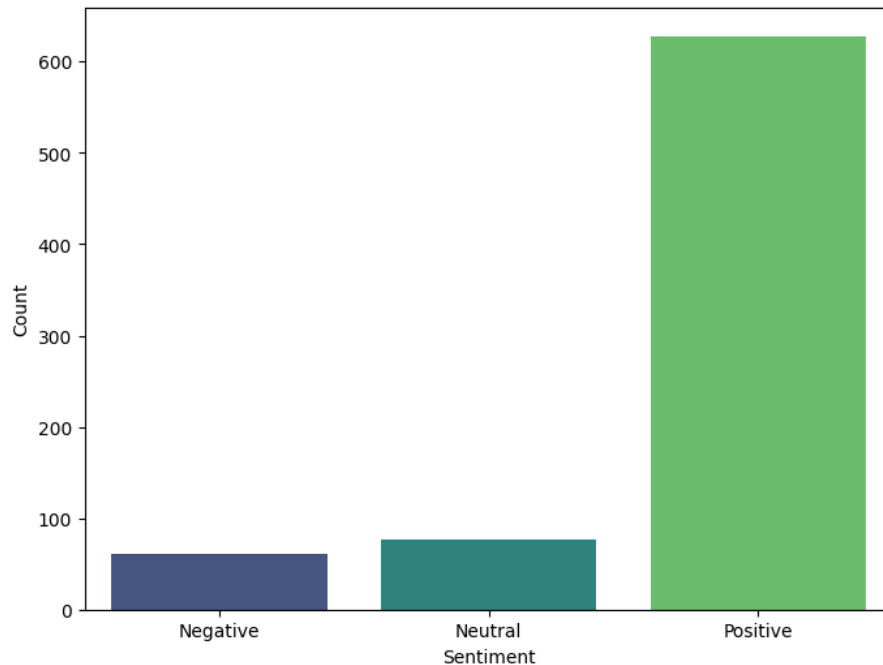


Figure 4.6. Sentiment distribution bar chart towards HR manager's perception

The analysis highlights a general optimism towards the adoption of blockchain technology in HR, showcasing HR Managers' positive perceptions of its benefits such as increased transparency, enhanced security, and improved efficiency. Relatively lower neutral and negative responses indicate fewer concerns or resistance. However, the presence of these sentiments underscores the need to address specific apprehensions or uncertainties during the implementation. This distribution provides critical insights for decision makers to focus on leveraging positive perceptions while mitigating challenges to ensure successful integration.

While positive sentiment dominated, the smaller shares of neutral and negative responses are also revealing. Neutral sentiments largely reflected cautious pragmatism: participants acknowledged blockchain's potential but withheld strong opinions due to limited personal exposure or organizational readiness. This neutrality underscores that blockchain in HRM remains a novel concept, with many practitioners waiting to see proven benefits before committing. Negative sentiments were linked primarily to concerns about implementation costs, integration challenges with existing HR systems, and the scarcity of technical expertise within HR departments. A few participants also voiced apprehension regarding data privacy and the risk of overcomplicating HR processes with advanced technology. Although smaller in proportion, these critical views highlight

practical barriers that must be addressed for successful adoption. Their significance lies in demonstrating that enthusiasm for blockchain is not unqualified; organizations will need to manage financial, technical, and cultural readiness before the technology can be fully integrated into onboarding and offboarding processes.

Sentiment Chart by Question

The radar chart depicting the sentiment distribution by question provides a detailed visual representation of stakeholder attitudes toward blockchain technology implementation in HR onboarding and offboarding. Each axis of the radar chart corresponds to a specific survey or interview question and the plotted points indicate the sentiment values (positive, neutral, or negative) associated with each question. This visualization revealed varying emotional responses across themes. For instance, questions addressing the potential of blockchain technology to enhance data security in onboarding often display strong positive sentiments, reflecting optimism regarding its utility. In contrast, questions focusing on challenges in integrating blockchain technology with existing HR systems reveal a mix of neutral and cautious sentiments, indicating stakeholders' reservations regarding practical implementation issues. The radar chart is particularly effective in highlighting sentiment variability across questions, offering a comprehensive understanding of stakeholders' perspectives. This insight is instrumental in identifying areas of enthusiasm and concern, allowing organizations to address specific challenges and strategically leverage the blockchain technology's strengths in HR processes.

The radar chart depicted in Figure 4.7 visualizes the distribution of sentiments (Positive, Neutral, and Negative) for each question in the survey. Each line represents one question (Q1–Q15), with its corresponding sentiment proportions mapped along the axes. The chart shows a clear clustering of positive sentiments towards the bottom of the radar, indicating that most responses across questions lean significantly toward positive perceptions. Neutral and negative sentiments appear less dominant and are distributed towards the upper segments of the chart.

The overlap of lines suggests consistency in sentiment trends across various questions, with positive feedback prevailing. This indicates that respondents across questions view the implementation of blockchain technology in HR onboarding and offboarding processes favorably. However, the presence of neutral and negative sentiments highlights areas that require further clarification or improvement. This chart serves as a comprehensive tool to identify sentiment

trends for individual questions and assess their alignment with the overall HR managers’ perspectives. It provides actionable insights for refining processes and addressing specific concerns to enhance blockchain technology adoption in HR onboarding and offboarding operations.

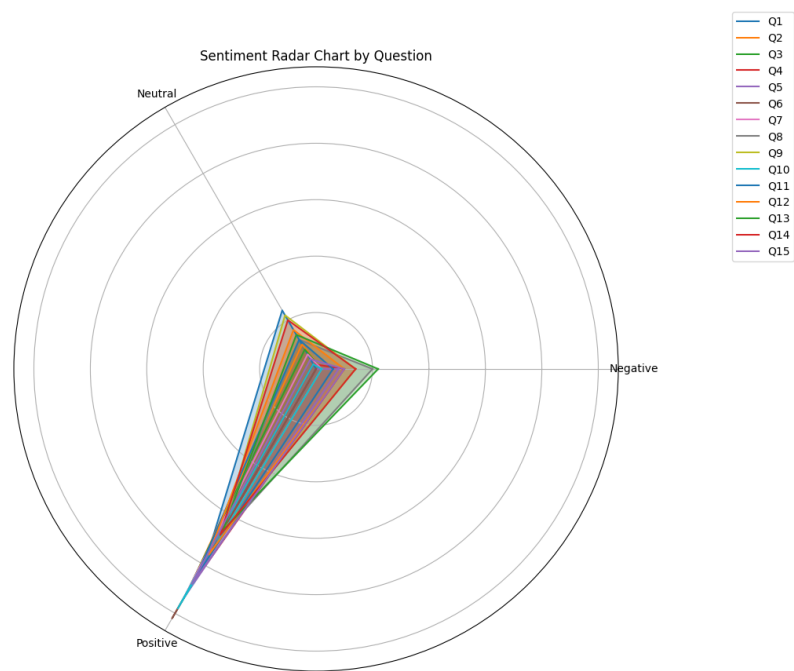


Figure 4.7. Sentiment radar chart by question

Sentiment Distribution based on the Designation of the HR

The stacked bar chart depicting sentiment distribution based on the designation of HR professionals provides a nuanced view of how sentiments toward blockchain technology implementation in HR onboarding and offboarding vary across roles. Each bar in the chart represents a specific designation, such as HR managers, recruitment specialists, or administrative staff, segmented into positive, neutral, or negative sentiment proportions. This visualization highlights role-specific attitudes and concerns. For instance, HR managers often exhibit a higher proportion of neutral sentiments, reflecting their focus on the strategic considerations and systemic implications of blockchain technology integration. Recruitment specialists, on the other hand, showed a tendency toward positive sentiments, likely due to the anticipated streamlining of candidate verification and onboarding processes. Administrative staff may display a mix of neutral and negative sentiments, possibly influenced by concerns about operational challenges and

technological adaptation. By analyzing the sentiment distribution across designations, this visualization offers actionable insights into stakeholder perspectives at various organizational levels. Understanding these differences allows targeted strategies to address specific concerns, foster acceptance, and maximize the potential benefits of blockchain technology in HR practices.

The stacked bar chart presented in Figure 4.8 illustrates the distribution of sentiment (positive, neutral, and negative) across different HR designations in an organization. The x-axis represents various HR roles, ranging from "Associate Vice President - HR" to "Senior HR Manager," while the y-axis displays the number of individuals expressing each sentiment. Sentiment is categorized into three groups: negative, neutral, and positive, with the corresponding colors in the legend.

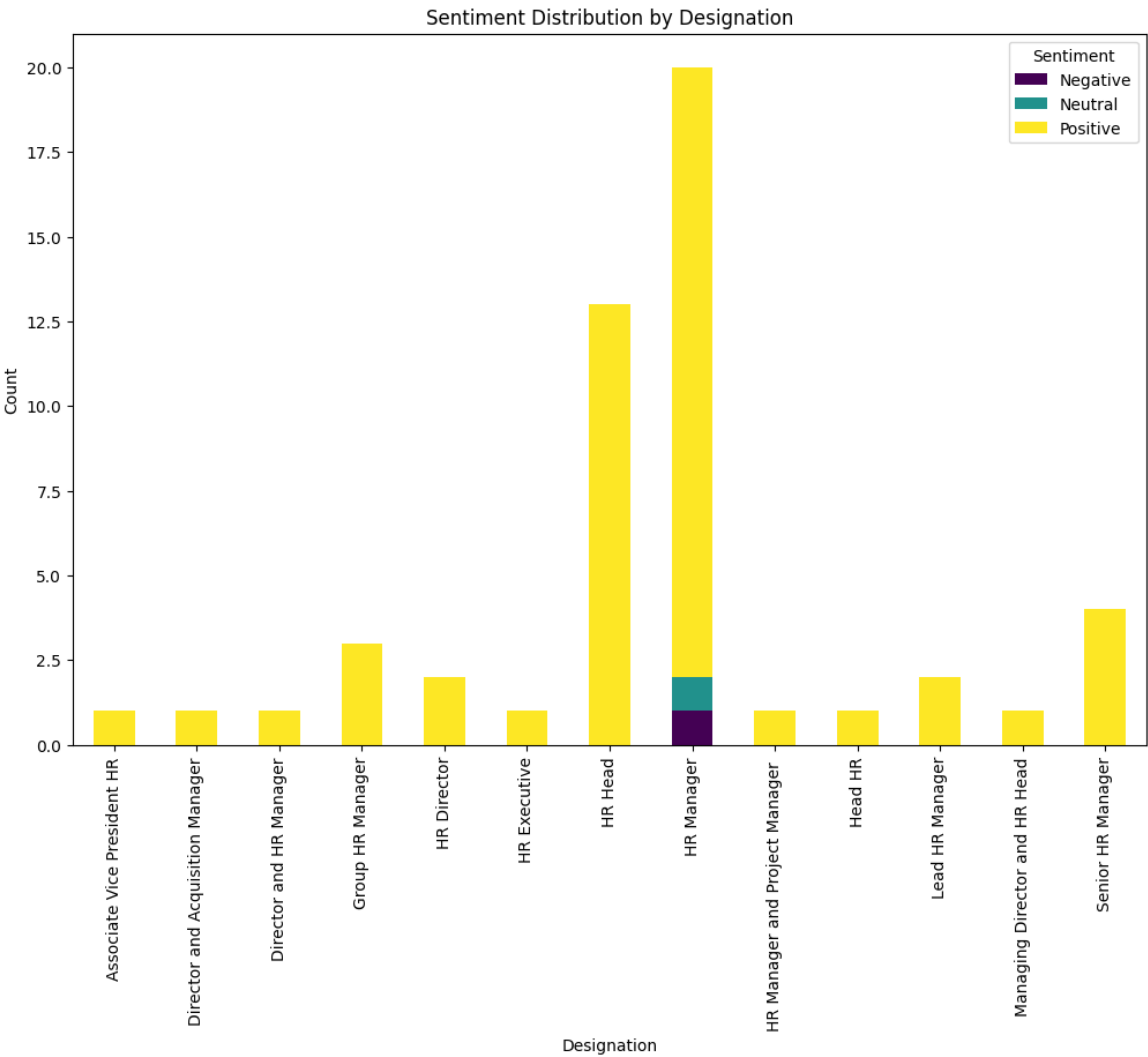


Figure 4.8. Sentiment distribution across various HR designations

A dominant trend in the chart is the overwhelming presence of positive sentiments (represented in yellow) across most designations. Particularly, "HR Manager" and "HR Head" roles stand out with significantly higher counts of individuals, showcasing positivity. Among these, the "HR Manager" designation records the highest sentiment distribution overall, with a small but noticeable presence of neutral (green) and negative (purple) sentiment. Other designations, such as "senior HR managers" and "group HR managers," also exhibit strong positive sentiments, though at comparatively lower counts. Interestingly, some designations like "HR Manager and Project Manager" and "Managing Director and HR Head" show relatively balanced sentiment distributions, with a noticeable number of neutral and negative sentiments alongside positive ones. Conversely, roles like "Associate Vice President - HR" and "HR Executive" show minimal representation, with predominantly positive sentiment.

Overall, the chart emphasizes the prevalence of positive sentiments among HR roles, with variations in sentiment distribution depending on the designation. The "HR Manager" designation plays a significant role in influencing the sentiment landscape due to its numerical dominance.

Overall Sentiment Distribution per Question

The heatmap chart depicting overall sentiment distribution per question provides a comprehensive visualization of the emotional tone associated with responses to specific questions in the study. Each cell in the heatmap corresponds to a combination of a question and sentiment category—positive, neutral, or negative—represented by a color gradient. The color intensity reflects the proportion of responses in a particular sentiment category for each question. This visualization is particularly valuable for identifying patterns and areas of concern or enthusiasm. For example, questions related to the potential of blockchain technology to enhance data security might show a predominance of positive sentiments, highlighted by vibrant colors in the heatmap. Conversely, questions addressing challenges in integrating blockchain technology into current HR processes could reveal a higher incidence of neutral or negative sentiments. By presenting sentiment data in this format, a heatmap allows researchers to quickly identify trends and outliers. It also provides a deeper understanding of how different aspects of blockchain technology adoption resonate with participants, enabling tailored recommendations for addressing stakeholder apprehensions and leveraging positive perceptions of HR onboarding and offboarding practices.

The heatmap presented in Figure 4.9 visualizes the distribution of sentiments (Negative, Neutral, and Positive) across multiple questions. Each row represents a question, and the columns denote the sentiment categories. The intensity of colors reflects the frequency of responses within each sentiment category, with darker shades indicating higher counts.

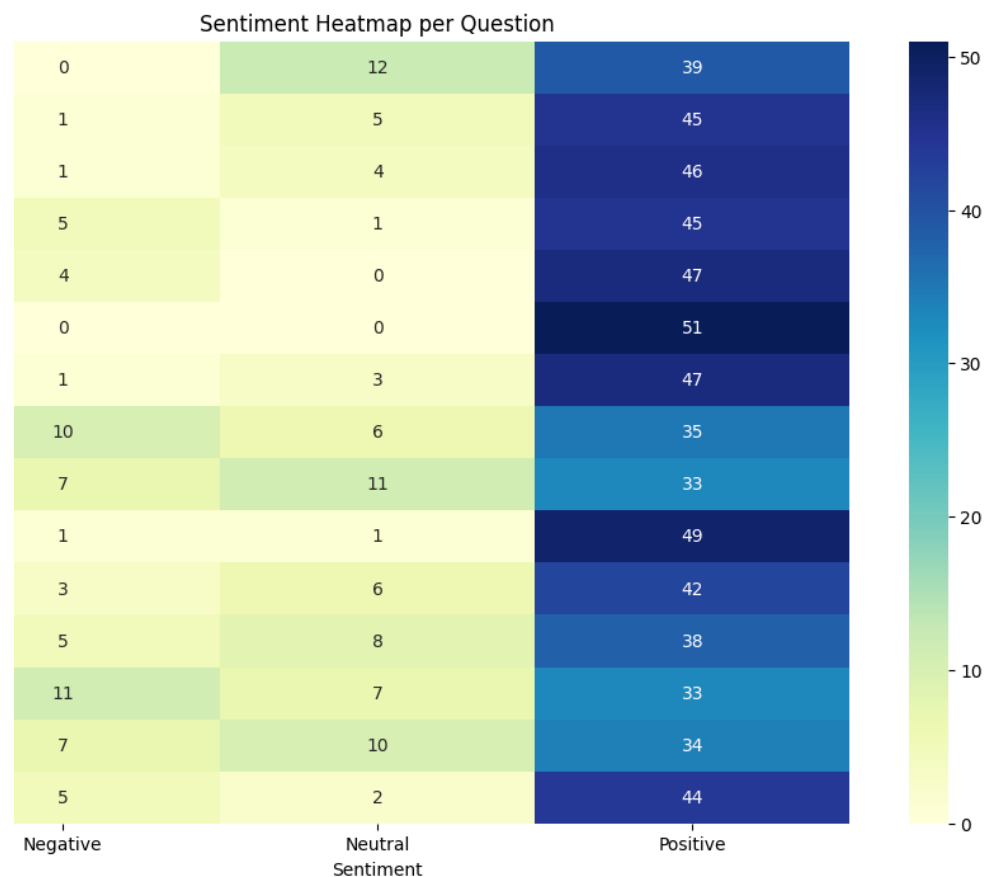


Figure 4.9. Sentiment heatmap across the question

Across all questions, the "Positive" sentiment column consistently shows the darkest shades, indicating that a significant majority of the responses are positive. For instance, one question received 51 positive responses, the highest among all, represented by the darkest blue. The "Neutral" sentiment column shows moderate distribution, with most questions receiving a lighter shade. This suggests that neutral responses are less frequent than positive ones but are still present, particularly in rows with counts ranging from 6 to 12. The "Negative" sentiment column exhibits the lightest shades overall, demonstrating a very low frequency of negative responses. A few questions had slightly higher negative counts (e.g., 10 and 11), indicating areas where participants

expressed dissatisfaction or concerns. Some questions showed a relatively balanced distribution between neutral and negative sentiments (e.g., questions with 10 negative and six neutral responses), which may reflect mixed perceptions or polarized opinions on those topics.

The overwhelming positivity in responses suggests that the questions or topics resonated well with the participants. Although limited, neutral and negative responses highlight areas that may require attention for improvement or further exploration. Questions with zero neutral responses (e.g., rows with neutral counts of 0) could indicate either a clear alignment in opinions (positive or negative) or a lack of middle ground responses.

Overall Sentiment Trend across Questions

The line chart depicting the overall sentiment trends across questions offers a clear depiction of the evolving sentiment patterns observed across the questions posed in the study. This chart visualizes how the proportion of positive, neutral, and negative sentiments varies for each question, providing a dynamic overview of participants' responses to the research topics. The line chart reveals the progression of sentiments, indicating areas of strong positive resonance, neutral viewpoints, or negative feedback. For example, questions addressing the potential of blockchain technology to improve HR onboarding might display a steady increase in positive sentiment, signifying optimism about its benefits. Conversely, inquiries related to the challenges of implementing blockchain technology could exhibit spikes in negative sentiments, highlighting apprehensions among stakeholders. This visualization is instrumental in identifying pivotal questions that evoke strong reactions, whether favorable or critical. This allows researchers to trace shifts in sentiment across the study, providing valuable insights into the broader narrative of blockchain technology integration in HR onboarding and offboarding processes. By analyzing these trends, this research can pinpoint key areas for intervention, improvement, or further exploration, contributing to more effective and targeted recommendations for organizational decision-making.

The trend chart depicted in Figure 4.10 illustrates the average sentiment score across the 15 survey questions (Q1 to Q15). The x-axis represents individual questions, while the y-axis displays the average sentiment score, ranging from 0 (negative sentiment) to 1 (positive sentiment). A continuous line connects the data points, highlighting the trend in sentiment variation across questions.

A clear fluctuation in sentiment is observed throughout the questions. The sentiment starts to be moderately high around Q1, increases steadily until Q6, and peaks with an average score of 1, indicating a strong positive sentiment. However, a sharp decline follows, with sentiment reaching its lowest point around Q8, which signifies a significant drop in positivity or an increase in negative responses to that particular question. After the low at Q8, the sentiment rebounds strongly at Q10 but exhibits another downward trend towards Q13, where it reaches another low point. Towards the end, there is a slight recovery, with a sentiment improvement between Q14 and Q15.

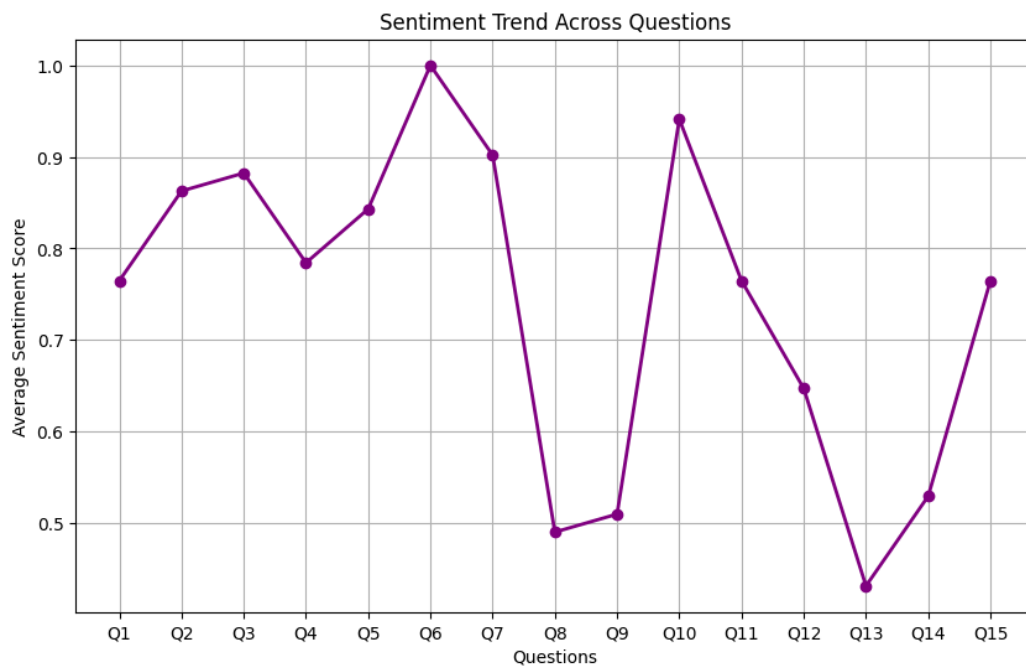


Figure 4.10. Sentiment trends across interview questions

Overall, the chart indicates varying respondent sentiment levels across the survey questions, with questions such as Q6 and Q10 eliciting the most positive responses, whereas Q8 and Q13 show areas of concern or dissatisfaction. These variations suggest that specific questions might address distinct topics or factors that influence respondent sentiment differently, warranting further investigation of the nature of these questions.

4.5. Summary

Chapter 4 serves as the pivotal phase in the research process, focusing on the transformation of raw data into actionable insights. It begins by emphasizing the critical role of data analysis in

bridging the gap between unprocessed information and meaningful conclusions, setting the stage for a structured approach to derive insights from various data sources. The chapter highlights Python as the primary programming language utilized for data analysis, praised for its flexibility, and extensive library support. Specific libraries such as pandas for data manipulation, matplotlib for data visualization, and NLTK (Natural Language Toolkit) and TextBlob for natural language processing tasks are discussed in detail.

Thematic analysis is a qualitative method employed to identify recurring patterns and themes within textual data, allowing researchers to organize insights according to their relevance to the research objectives. Complementing this, content analysis is described as a systematic method for quantifying and categorizing textual data, providing numerical evidence to support the identified themes. This process involves coding and categorizing data to uncover key trends and their frequency of occurrence. Additionally, this chapter covers sentiment analysis, which evaluates the emotional tone of the collected data by assessing the polarity of opinions expressed within the dataset—whether they are positive, negative, or neutral. This understanding of stakeholder perspectives is crucial for identifying sentiments that influence behavior and decision-making.

Following coding and categorization, this chapter details the quantification and analysis phase, where the frequency and distribution of identified themes are examined, offering insights into the prevalence of certain themes and the significance of specific concepts within the data. Visual tools, such as radar charts and trend charts, were referenced to illustrate sentiment distribution and trends across survey questions, aiding in the comprehension of the overall sentiment landscape and identifying areas for improvement. The chapter concludes by discussing the various tools and software that enhance content analysis methodology, emphasizing the role of Python and its libraries in automating and streamlining the analysis process, ultimately making it more efficient and scalable. Chapter 4 provides a comprehensive overview of the data analysis process, detailing the methodologies, tools, and techniques used to derive meaningful insights from diverse data sources, thereby contributing to informed decision-making and recommendations for organizational practices.

Chapter 5: Proposed Framework and Implementation

This chapter introduces the conceptual framework and implementation strategy designed to integrate blockchain technology into the HR onboard and offboarding processes. The proposed framework aims to address the limitations identified in existing mechanisms while leveraging blockchain technology's unique features, such as transparency, security, and data immutability. Through a systematic and innovative approach, this chapter outlines how the integration of blockchain technology can streamline workflows, enhance trust, and ensure compliance with data-protection standards. Furthermore, the implementation section provides a detailed roadmap highlighting the technological, procedural, and organizational considerations required for the transition from traditional HR systems to a blockchain technology-enabled environment. The framework's design reflects insights derived from thematic and sentiment analyses, ensuring that the solution is tailored to effectively address stakeholder needs and industry challenges.

This chapter is divided into eight sections: Section 5.1 provides the conceptual framework of the human resource onboarding and offboarding processes. Section 5.2 discusses an architectural diagram of the proposed framework. Section 5.3 provided a flow diagram of the proposed framework. Section 5.4 and 5.5 provides the proposed frameworks of onboarding and offboarding, respectively. Section 5.6 discusses the blockchain technology implementation of the onboarding and offboarding processes. Section 5.7 provides a comparison of the proposed framework with the state-of-the-art frameworks. Finally, section 5.8 provides a summary of this chapter.

5.1. Conceptual Framework of Human Resource Onboarding and Offboarding Processes

A conceptual framework diagram serves as a foundational blueprint outlining the theoretical underpinnings, key concepts, and relationships central to a research study or project. In the context of this study on blockchain technology-based HR management in the automobile manufacturing industry, a conceptual framework diagram plays a crucial role in delineating the core elements and principles guiding the development and implementation of the proposed system. It visually represents the interplay between inputs, processes, outputs, and stakeholders within the HR management framework, illustrating how data flows from initial capture through processing to final outcomes, such as employee onboarding and offboarding records. By mapping out these

conceptual components, the diagram helps researchers and stakeholders conceptualize complex ideas, identify variables of interest, and articulate hypotheses or research questions. Furthermore, the conceptual framework diagram serves as a roadmap for aligning research objectives with practical implementation strategies, ensuring coherence and consistency in the development of blockchain technology-based HR solutions. It is important to provide a structured approach to understand and address the challenges and opportunities inherent in HR management within the automobile manufacturing sector, thereby guiding decision-making, fostering innovation, and enhancing the overall effectiveness of the research endeavor.

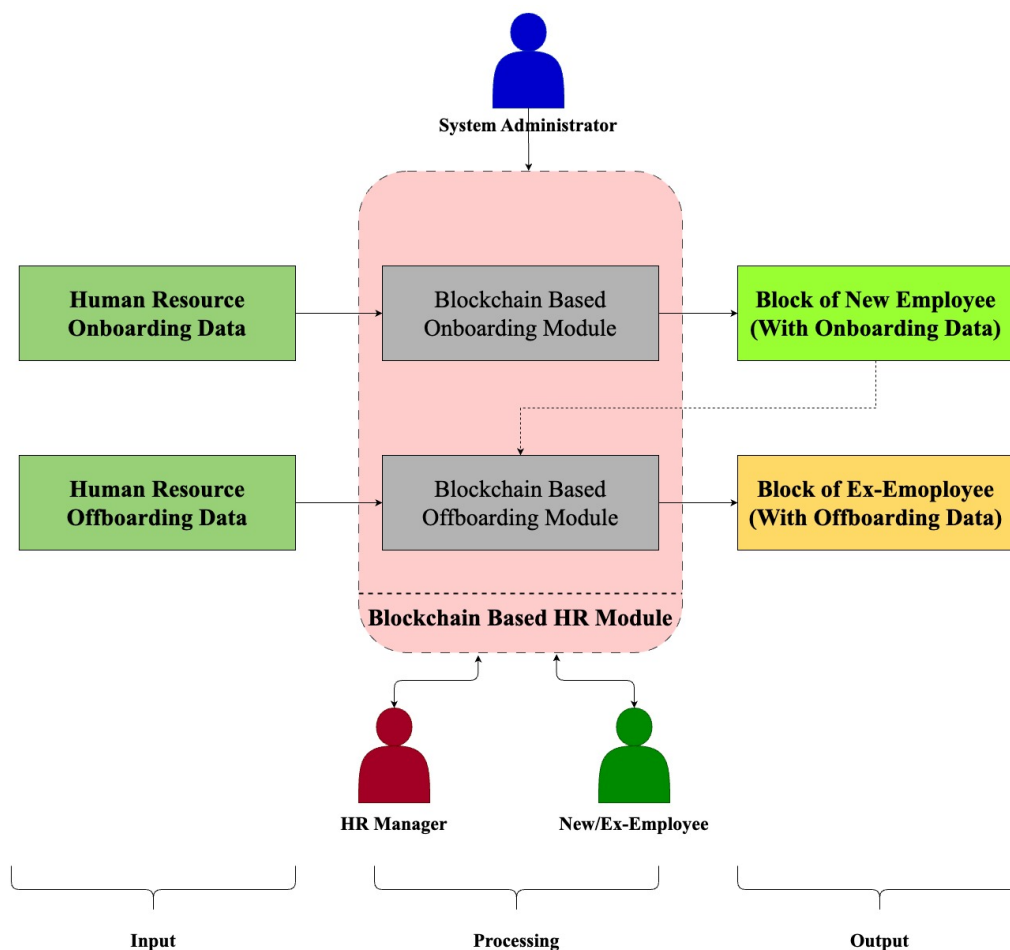


Figure 5.1. Conceptual diagram of the proposed framework

The conceptual framework for HR onboarding and offboarding processes in the automobile manufacturing industry outlines a structured approach to managing the lifecycle of employees within an organization. The framework presented in Figure 5.1 integrates principles of efficiency,

compliance, and transparency, leveraging blockchain technology to enhance data security and streamline operational workflows. The conceptual framework for HR onboarding and offboarding in the automobile manufacturing industry offers several distinct advantages. By integrating blockchain technology, organizations can enhance operational efficiency, mitigate risks associated with data tampering or unauthorized access, and improve regulatory compliance. The framework facilitates the real-time visibility of employee lifecycle events, enabling proactive decision making and resource allocation.

Moreover, it supports continuous improvement initiatives by providing actionable insights derived from blockchain technology-secured data, thereby driving organizational growth and resilience in a dynamic industrial landscape. The conceptual framework provides a structured approach for managing HR processes within the automobile manufacturing sector, aligning technological innovation with strategic business objectives. By fostering transparency, efficiency, and compliance, the framework empowers organizations to optimize workforce management practices and maintain competitive advantage in an increasingly digitalized marketplace.

5.1.1. Components of Conceptual Diagram

The conceptual diagram illustrates a blockchain technology-based HR management system tailored for handling the onboarding and offboarding processes in an organization. It is divided into input, processing, and output layers with clear roles and functionalities for each component. The key components are as follows:

Input Modules: Human Resource Onboarding Data module serves as the input point for new employee data. It captures essential details, such as personal information, job roles, departments, and other onboarding-related information. Human Resource Offboarding Data module collects and processes information about employees leaving the organization, including exit formalities, clearance details, and feedback data.

Blockchain Technology -Based HR Module: This central processing unit is responsible for managing both the onboard and offboarding workflows. It acts as the backbone of the system, leveraging the blockchain technology to ensure secure, immutable, and transparent data handling. The HR module comprises two sub-modules:

Blockchain technology-Based Onboarding Module: Processes onboard data to generate a blockchain technology record for new employees. It ensures data integrity and automates onboarding tasks by using smart contracts.

Blockchain technology-based Offboarding Module: Handles the offboarding process using existing onboarding data to complete the necessary formalities. It generates an offboarding block in the blockchain technology to securely document the exit process.

Output Modules: Block of new employees is generated during the onboarding process. It securely stores information about newly onboarded employees. Block of ex-employees created by the offboarding module, records the details of employees leaving the organization, ensuring a complete and traceable employee lifecycle.

System Administrator: The system administrator oversees the entire process, ensuring that all the modules function as intended. They manage access control, monitor the blockchain technology network, and ensure compliance with organizational policies.

Key Stakeholders: HR Manager is responsible for supervising and verifying HR-related activities in both onboarding and offboarding processes. New/Ex-Employee represents individuals whose data are processed during their onboarding or offboarding stages.

Blockchain Technology Features: The system utilizes a Practical Byzantine Fault Tolerance (PBFT) consensus mechanism to validate transactions and ensure consistency across the blockchain technology network. Smart contracts ensure automate HR processes, including verification, task assignment, and record generation, ensuring accuracy and efficiency.

5.1.2. Working of Conceptual Diagram

The conceptual diagram represents the operational flow of a blockchain technology-based HR management system designed to streamline the onboarding and offboarding processes. It integrates multiple components to create a secure, transparent, and immutable record-keeping system for employee life cycle management. The functionality of the system was divided into three main stages: input, processing, and output.

The system begins by gathering data through two distinct input modules: human resource onboard data and offboarding data modules. The onboarding data include information about new employees, such as personal details, job roles, department assignments, and specific onboarding requirements. Conversely, the offboarding data capture critical information about departing employees, including clearance tasks, exit interview feedback, and equipment return details. These modules ensure that the system collects all relevant information to process employee transitions efficiently.

The blockchain technology-based HR module, which acts as the central processing unit, lies at the core of the system. It is subdivided into two modules: blockchain technology-based onboarding Module and the blockchain technology-Based offboarding module.

When new employee data are received, the onboarding module validates the information and initiates an onboarding workflow. This includes automating tasks, such as assigning job roles, initiating training programs, and creating access credentials. Using smart contracts, this module ensures that every step of the process is accurately and efficiently executed. Upon completion, the module generates a blockchain technology block called the Block of New Employee, which securely stores all the onboarding-related details. This block ensures data integrity and prevents unauthorized modifications.

For departing employees, the offboarding module retrieves relevant information from a block of new employees created during onboarding. This ensures that the employee's lifecycle is seamlessly traced and validated. The module automates offboarding tasks such as revoking access, processing final settlements, and ensuring the clearance of responsibilities. Once the offboarding workflow is complete, the module generates a new blockchain technology block called the block of the ex-employee, which securely records the employee's exit details.

The output stage of the system involves the creation of two distinct blockchain technology records: a block of new employees and a block of ex-employees. These blocks serve as permanent tamper-proof records for the organization's HR processes. They provide transparency and traceability for all employee lifecycle events, while ensuring compliance with organizational and regulatory requirements.

Key stakeholders play an essential role throughout the process. The System Administrator oversees the system operations, ensuring proper functioning and security. HR Managers monitor workflows and approve key actions, while New and Ex-Employees contribute the data that form the foundation of the system's functionality.

This conceptual framework leverages the blockchain technology's features, including a PBFT consensus mechanism and smart contracts, to ensure data security, operational efficiency, and trust. By automating processes and creating immutable records, the system minimizes errors, reduces manual workload, and ensures seamless transition for both onboarding and offboarding activities.

5.2. Architectural Diagram of the Proposed Framework

An architectural diagram serves as a visual representation of structural components, interactions, and dependencies within a system or framework. In the context of this research, which focused on blockchain technology-based HR management in the automobile manufacturing industry, an architectural diagram plays a pivotal role in illustrating how various modules, processes, and technologies are integrated to achieve specific objectives. It provides a comprehensive overview of the system's design, highlighting key components such as input modules for data ingestion, blockchain technology-based processing units for secure transaction management, output modules for data storage, and the roles of stakeholders such as system administrators and HR managers. The diagram not only elucidates the technical architecture of the system but also underscores its operational workflows and technological dependencies. Its importance lies in facilitating a clear understanding among stakeholders, aiding in system design and implementation, ensuring alignment with organizational goals, and serving as a blueprint for effective communication and collaboration across teams involved in developing and deploying blockchain technology-based HR solutions. By visualizing the system architecture, stakeholders can identify potential bottlenecks, optimize performance, and ensure robustness in handling critical HR processes within the dynamic and regulated environment of automobile manufacturing.

The architectural diagram presented in Figure 5.2 for the proposed framework outlines a robust and scalable infrastructure designed to support a blockchain technology-based HR management system tailored to the automobile manufacturing industry. This diagram encapsulates the structural components and technological dependencies necessary to ensure efficient operation and secure

data management throughout the employee's lifecycle. The proposed architectural diagram offers several advantages for the automobile manufacturing industry. It enhances operational efficiency by automating repetitive HR tasks, reduces administrative overhead through streamlined workflows, and strengthens data security using blockchain technology cryptographic principles. Moreover, the system provides real-time visibility of employee lifecycle events, enabling proactive decision-making and compliance monitoring. The architectural diagram of the proposed blockchain technology-based HR framework underscores its capacity to revolutionize HR management in the automobile manufacturing sector. By leveraging advanced technologies and adhering to industry best practices, the framework promises to elevate efficiency, transparency, and security in managing workforce transition and regulatory compliance.

5.2.1. Components of Architectural Diagram

The components of an architectural diagram are the foundational elements that define the structure and functionality of a complex system or framework. In the context of designing a blockchain technology-based HR management system for the automobile manufacturing industry, an architectural diagram serves as a visual representation of how various technological and organizational components interact to achieve specific operational goals. This diagram articulates the relationships between input, processing, and output modules within the system, illustrating the flow of data, roles of stakeholders, and integration of key technologies such as blockchain technology and smart contracts. The major components of the architectural diagram are as follows:

Users: Users interact with the system through input modules. There are two types of users. System Administrator, responsible for managing configurations and permissions. HR Managers, responsible for feeding onboarding and offboarding data into the system. New/Ex Employees, acting as the source of data for onboarding/offboarding.

Input Modules: Collect data for onboarding and offboarding. Pass data to smart contracts for validation and business rule execution.

Smart Contracts: Serve as automated logic layers for validating data and applying onboarding rules. Fetching onboarding data, validating inputs, and applying offboarding rules. It also triggers blockchain technology transactions upon successful execution.

Processing Unit: It is responsible for executing the core processing logic by preparing onboarding data for block creation in onboarding module. Fetching onboarding data and prepare offboarding data for block creation in offboarding module.

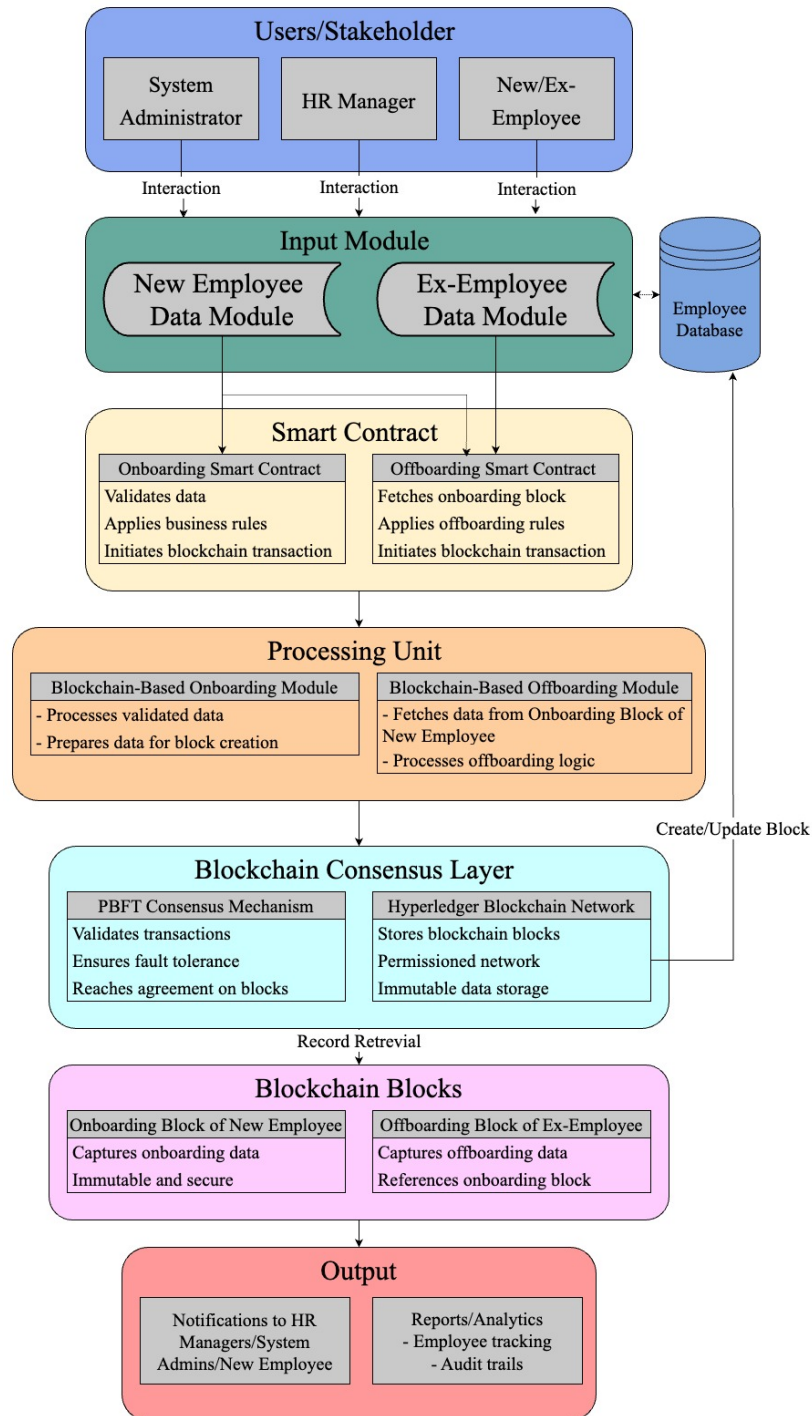


Figure 5.2. Architectural diagram of the proposed framework

Blockchain Technology Consensus Layer: PBFT Consensus Mechanism ensures all nodes agree on the validity of blocks and transactions. Ensures fault tolerance and security.

Hyperledger Blockchain Technology Network: A permissioned blockchain technology network used to store immutable, tamper-proof blocks.

Blockchain Technology Blocks: Onboarding and offboarding data are stored in separate blocks. Onboarding block of new employee captures the onboarding data. Offboarding block of ex-employees is used for referencing the onboarding block and stores offboarding data.

Output: Notifications are sent to users for status updates. Optional reports/analytics can be generated for audits or employee tracking.

5.2.2. Working of Architectural Diagram

The architectural diagram of the blockchain technology-based HR system shows the structured flow of data and functionalities across various components. Users interact with the system at the forefront, including system administrators, HR managers, and employees (both new hires and those leaving the organization). Each user has defined roles and permissions that enable them to perform specific tasks. The interaction begins with the input modules responsible for collecting data. For onboarding, the "New Employee Data Module" captures information about new hires, while the "Ex-Employee Data Module" gathers the necessary details for offboarding.

Once the data are provided, they flow to the smart contract layer. Onboarding and offboarding smart contracts serve as automated programs that validate the input data and apply predefined business rules. For example, the onboarding smart contract ensures that the provided employee information is complete and adheres to organizational requirements, whereas the offboarding smart contract retrieves the associated onboarding data for processing tasks such as access termination or final settlements. These contracts act as critical checkpoints, ensuring accuracy and triggering blockchain technology transactions only if the conditions are met.

The validated data are then forwarded to the processing unit, which includes the blockchain technology-based onboarding and offboarding modules. The onboarding module processes the new employees' information and prepares it for blockchain technology integration, creating a data structure that aligns with the blockchain technology's block format. Similarly, the offboarding

module retrieves historical data from the onboarding block of the respective employee, and processes the offboarding details for further blockchain technology storage.

The next is the blockchain technology consensus layer, where the system employs the Practical Byzantine Fault Tolerance (PBFT) mechanism to achieve agreement among network nodes. This ensures that transactions are valid and prevents tampering even in the presence of malicious actors. Once consensus is reached, the validated transactions are added as blocks to the hyperledger blockchain technology network, a permissioned ledger designed for secure and transparent data storage. Each block in the blockchain technology is immutable, and serves as a permanent record. The onboarding module creates an "Onboarding Block of New Employee," while the offboarding module generates an "Offboarding Block of Ex-Employee." The latter refers to the corresponding onboarding block to ensure data continuity and traceability.

Finally, the system generates outputs, including notifications sent to relevant stakeholders such as HR managers, system administrators, and employees. These updates inform them of the status of the onboarding or offboarding processes. In addition, the system can produce optional analytics or reports, providing insights into employee trends, compliance metrics, and system performance.

This architecture integrates users, data processing, automation via smart contracts, consensus mechanisms, and blockchain technology to deliver a secure, efficient, and transparent HR management solution. By leveraging Hyperledger and PBFT, the system ensures data consistency, fault tolerance, and compliance with organizational and regulatory standards, making it a robust framework for employee lifecycle management.

5.3. Flow Diagram of the Proposed Framework

A flow diagram is a graphical representation that illustrates the sequential flow of processes, interactions, and data within a system or framework. In the context of this research, which focused on developing a blockchain technology-based HR management system for the automobile manufacturing industry, a flow diagram plays a critical role in visualizing the operational workflows and dependencies involved in employee onboarding and offboarding processes. It maps the step-by-step progression from data input to output, highlighting the logical sequence of actions, decision points, and interactions between stakeholders and technological components. The

importance of a flow diagram in this study lies in its ability to provide a clear and structured overview of how the proposed framework operates in practice. By visualizing the flow of information and tasks, the diagram enhances the understanding among stakeholders, including system architects, HR managers, and IT specialists, about the system's operational mechanics and functional requirements. It serves as a blueprint for system design, guiding the implementation of key features, such as data validation, blockchain technology integration, and smart contract execution.

Furthermore, the flow diagram aids in identifying potential bottlenecks, optimizing process efficiency, and ensuring regulatory compliance throughout the employee lifecycle. It facilitates communication and collaboration across multidisciplinary teams involved in system development, fostering alignment with organizational goals and enhancing decision-making processes. Ultimately, the flow diagram acts as a foundational tool for refining and iterating the proposed framework, enabling continuous improvement and adaptation to evolve industrial standards and technological advancements.

The flow diagram for the proposed blockchain technology-based HR management framework in the automobile manufacturing industry illustrates the systematic flow of processes and interactions essential for managing employee onboarding and offboarding with efficiency, transparency, and security. This graphical representation, depicted in Figure 5.3 serves as a pivotal tool for visualizing the sequence of operations, data flows, and stakeholder interactions within the HR management system. The flow diagram of the proposed framework offers significant advantages to the automobile manufacturing industry. By visualizing and optimizing the flow of HR processes, organizations can streamline operations, reduce administrative overheads, and enhance employee experience from onboarding to offboarding. The use of blockchain technology ensures data security, transparency, and compliance with regulatory requirements, thus fostering trust and reliability in managing critical HR functions. The flow diagram serves as a comprehensive blueprint for designing and implementing a blockchain technology-based HR management system tailored to specific needs of the automobile manufacturing sector. It provides a structured approach for visualizing operational workflows, identifying process efficiencies, and aligning technological innovations with strategic business objectives. Through continuous refinement and adaptation, the

flow diagram supports organizational resilience and growth in an increasingly digitalized and competitive industry landscape.

5.3.1. Components of Flow Diagram

The components of a flow diagram encapsulate the essential elements and sequential steps that define the operational flow within the system or framework. In the context of developing a blockchain technology-based HR management system for the automobile manufacturing industry, the flow diagram delineates the systematic progression of processes, data interactions, and stakeholder engagement involved in managing employee onboarding and offboarding. Each component within the flow diagram plays a critical role in visualizing how data move through the system, from the initial input and processing stages to the final outputs and outcomes. By providing a visual representation of these components, the flow diagram facilitates a clear understanding of the operational mechanics, dependencies, and integration points of the system. It serves as a foundational tool for stakeholders, including system architects, HR managers, and IT specialists, to collaboratively design, implement, and optimize the proposed framework and ensure alignment with organizational goals and operational excellence in effectively managing HR processes within the automobile manufacturing sector.

Input Modules: The flow diagram begins with two primary input modules: "New Employee Data for Onboarding" and "Ex-Employee Data for Offboarding." These modules serve as entry points for capturing essential information related to new hires and departing employees in the automobile manufacturing industry.

Blockchain Technology -Based HR Module: Central to the flow diagram is the blockchain technology -Based HR Module, which processes the input data from both the onboarding and offboarding modules. This module utilizes blockchain technology to ensure secure, transparent, and immutable record keeping of employee lifecycle events.

Onboarding Module: Specifically designed for new employees, the Onboarding Module within the flow diagram focuses on integrating fresh hires into the organization's workforce. It generates an "Onboarding Block of New Employees " within the blockchain technology, capturing relevant details such as personal information, job role, and initial training requirements.

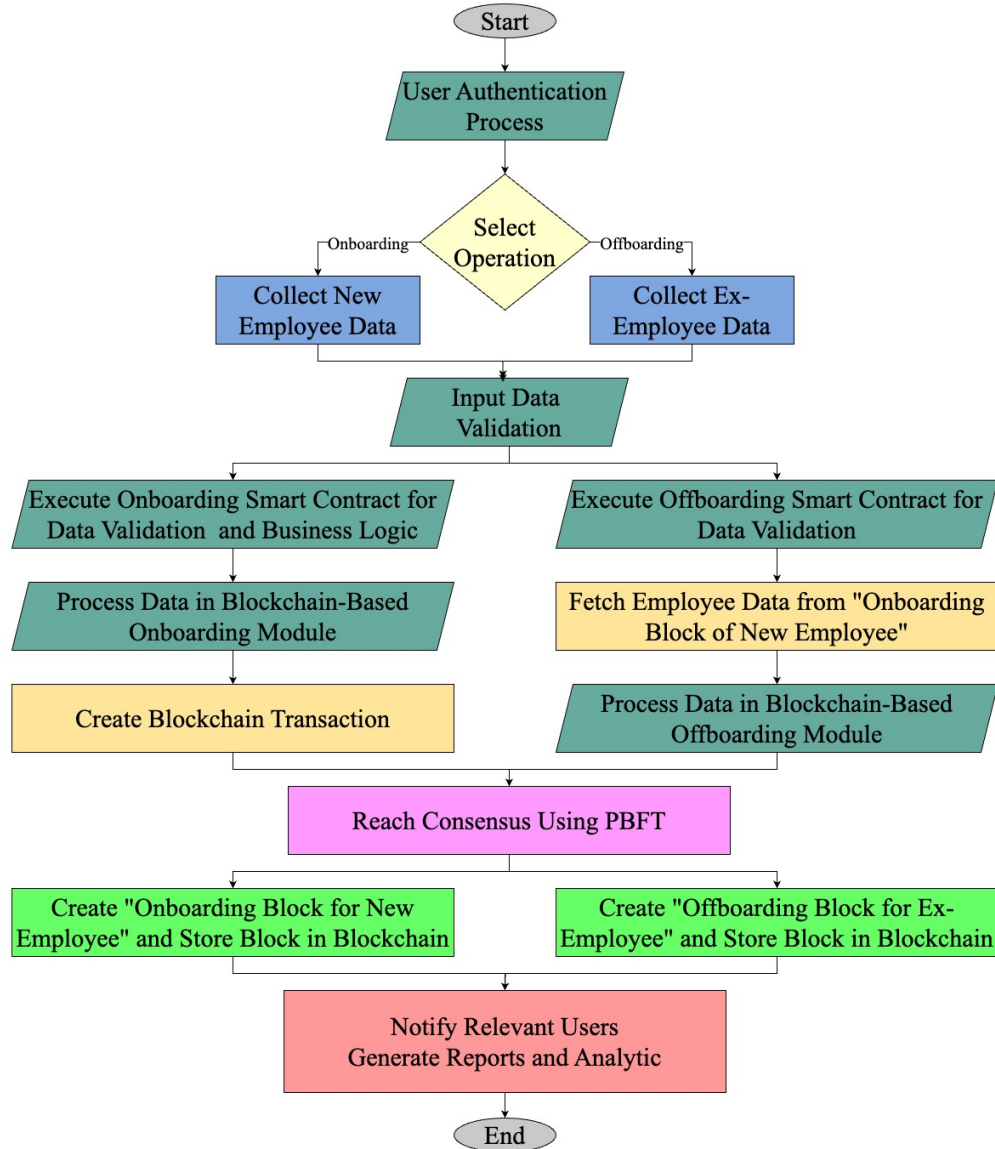


Figure 5.3. Flow diagram of the proposed framework

Offboarding Module: Conversely, the Offboarding Module manages the departure process of ex-employees. It references the "Onboarding Block of New Employee" stored in the blockchain technology to facilitate smooth transitions, ensuring that tasks such as equipment return, access revocation, and exit interviews are efficiently handled. The module creates an "Offboarding Block for Ex-Employee" to securely document the employee's departure details.

Entities Involved: Key entities depicted in the flow diagram include "System Administrator," responsible for overseeing system operations and user management, ensuring compliance with data privacy regulations and internal policies. "New and Ex-Employee" roles highlight the primary

stakeholders affected by onboarding and offboarding processes, ensuring their data integrity and privacy throughout their employment lifecycle. "HR Managers" play a crucial role in overseeing HR operations, utilizing blockchain technology's benefits for streamlined management and enhanced security.

Consensus Mechanism and Technology Stack: The flow diagram incorporates the Practical Byzantine Fault Tolerance (PBFT) consensus mechanism, a proven approach in distributed systems that ensures agreement among nodes regarding the validity of transactions. Hyperledger Fabric, a permissioned blockchain technology framework, serves as the foundational technology stack, enabling the implementation of smart contracts tailored to effectively automate and enforce HR policies and workflows.

5.3.2. Working of Flow Diagram

The flow diagram illustrates the systematic operation of a blockchain technology-based HR system tailored to the automobile manufacturing industry, focusing on streamlined employee onboarding and offboarding processes. At its core, the diagram begins with two crucial input modules: "New Employee Data for Onboarding" and "Ex-Employee Data for Offboarding." These modules serve as gateways for capturing essential information related to personnel entering and exiting an organization.

Upon receiving input, the blockchain technology -Based HR module takes the center stage, leveraging blockchain technology to ensure secure, transparent, and immutable recording of employee lifecycle events. The module operates on a Hyperledger Fabric framework, known for its permissioned blockchain technology architecture suitable for enterprise environments. This setup facilitates robust data management and compliance with regulatory requirements, which are crucial in an industry regulated by automobile manufacturing. The Onboarding Module, which is a pivotal component of the flow, orchestrates the integration of new employees into the workforce. It is initiated by validating the incoming data against predefined criteria to ensure accuracy and completeness. Once validated, the module generates an "Onboarding Block of New Employees " within the blockchain technology. This block securely stores pertinent details such as personal information, job roles, assigned tasks, and initial training requirements. The use of smart contracts automates onboarding workflows, enhances efficiency, and reduces administrative overhead.

Conversely, the Offboarding Module oversees the departure process of former employees with equal diligence. It references the "Onboarding Block of New Employees " stored in the blockchain technology to facilitate smooth transitions. Tasks such as equipment return, access revocation, and exit interviews are systematically managed to maintain operational continuity and data security standards. The module creates an "Offboarding Block for Ex-Employees," documenting comprehensive departure details while ensuring compliance with organizational policies and legal obligations. Throughout this operational workflow, key entities, such as System Administrators, New and Ex-Employees, and HR Managers, play critical roles. System Administrators oversee system integrity and user management, whereas HR Managers utilize blockchain technology benefits to optimize HR operations effectively. The PBFT consensus mechanism ensures consensus among nodes regarding the validity of transactions, thereby reinforcing data integrity and system reliability.

The implementation of the flow diagram in the automobile manufacturing industry demonstrates its capacity to enhance operational efficiency, data security, and regulatory compliance. By leveraging blockchain technology and smart contracts, the system automates and streamlines HR processes, offering a scalable solution for managing dynamic workforce transitions in a highly regulated environment.

5.4. Proposed Framework of Onboarding Process

An effective onboarding framework is essential for seamlessly integrating new employees into an organization. The onboarding process serves as a critical point to ensure that employees feel welcomed, supported, and aligned with organizational objectives. Without a structured approach, organizations may face increased turnover rates, reduced productivity, and misalignment in their goals. A well-crafted onboarding framework addresses key challenges, such as adapting to workplace culture, understanding job expectations, and ensuring compliance with legal and operational standards. A robust onboarding framework not only ensures the successful integration of new employees but also reinforces the organization's commitment to its workforce. By addressing both the operational and cultural aspects, this framework sets the foundation for long-term success and growth.

5.4.1. Proposed Framework of Onboarding Workflow

The onboarding framework is illustrated in Figure 5. Four serves as a roadmap for creating a seamless transition for new employees. By establishing a step-by-step process, the framework ensures that every new hire undergoes the same comprehensive onboarding experience, thereby reducing inconsistencies and inefficiencies. The framework incorporates checkpoints to verify compliance with legal and safety standards and to minimize the risk of non-compliance penalties. A structured onboarding process helps employees feel welcomed and prepared, fostering their engagement and motivation. This demonstrates the organization's commitment to professional growth and well-being. With clear task assignments and immediate access provisioning, employees can begin to contribute to their roles more quickly, thereby accelerating productivity. Proper verification of documents and compliance with safety protocols reduces the risks associated with incomplete onboarding processes.

Components of the Onboarding Framework

The onboarding framework is a structured and sequential process designed to address the various facets of employee induction. As shown in the flowchart, this framework involves several stages.

Initiate New Employee Onboarding: The onboarding process begins when the HR receives a formal request and sets up the necessary procedures. This phase ensures that the foundation for a smooth onboarding journey is laid.

Identity Verification and Document Submission: Employees provide identification, certifications, and other essential documents. Documents were reviewed by third-party verifiers to ensure accuracy, compliance, and safety clearance.

Employment Agreement and Access Permissions Setup: Employment contract terms are finalized, outlining the rights and responsibilities of both employees and employers. Access permissions were configured based on the roles, responsibilities, and training levels of the new hire.

Departmental Task Assignment: Tasks are divided among key departments. HR oversees benefits enrollment and safety briefings. IT prepares digital access credentials and work devices. Safety and compliance teams arrange for necessary equipment and schedule safety training sessions.

Access Provisioning: Employees are granted access to the specific zones, tools, and systems that they need to perform their roles. This ensures that their operational readiness is aligned with company protocols.

Data Storage and Compliance Review: Employee data is securely stored to protect personal information. Management ensures compliance with safety (OSHA) and quality (ISO) standards.

Final Approval and Onboarding Completion: HR and department heads review all steps, ensuring every detail has been addressed. Once validated, the onboarding process is marked as complete and the employee's status is updated in the organizational records.

Working of Proposed Onboarding Framework

The onboarding framework is a structured approach designed to seamlessly integrate new employees into an organization. It begins with the HR receiving the onboarding request and setting up the necessary workflows, ensuring that all stakeholders are aligned for a smooth process. This stage is crucial for organizing resources and preparing for coordination across departments. The next step involves identity verification and document submission, where employees provide essential documents such as identification proofs, certifications, and prior work records. These documents are thoroughly reviewed by third-party verifiers or internal teams to confirm authenticity and ensure compliance with safety and regulatory requirements, which are especially critical in industries such as manufacturing.

Following this, the employment agreement is finalized, outlining the terms and conditions of the job, while role-based access permissions are set up to grant appropriate access to tools, systems, or facilities. This ensures that the new hire has the required resources without compromising security. Once these foundational elements have been established, departmental tasks are assigned. HR handles benefits administration and conducts safety orientations, IT prepares digital devices and sets up necessary software access, and the Safety and Compliance team schedules mandatory training and allocates safety equipment, as required.

In the access provisioning stage, specific permissions are granted based on the operational requirements of the role, such as access to restricted zones or specialized equipment for manufacturing employees. This ensures that employees begin their tasks without unnecessary delays. Concurrently, employee data are securely stored in compliance with legal and

organizational standards such as ISO or OSHA, and management reviews the onboarding process to confirm adherence to regulatory guidelines. Discrepancies were identified and resolved.

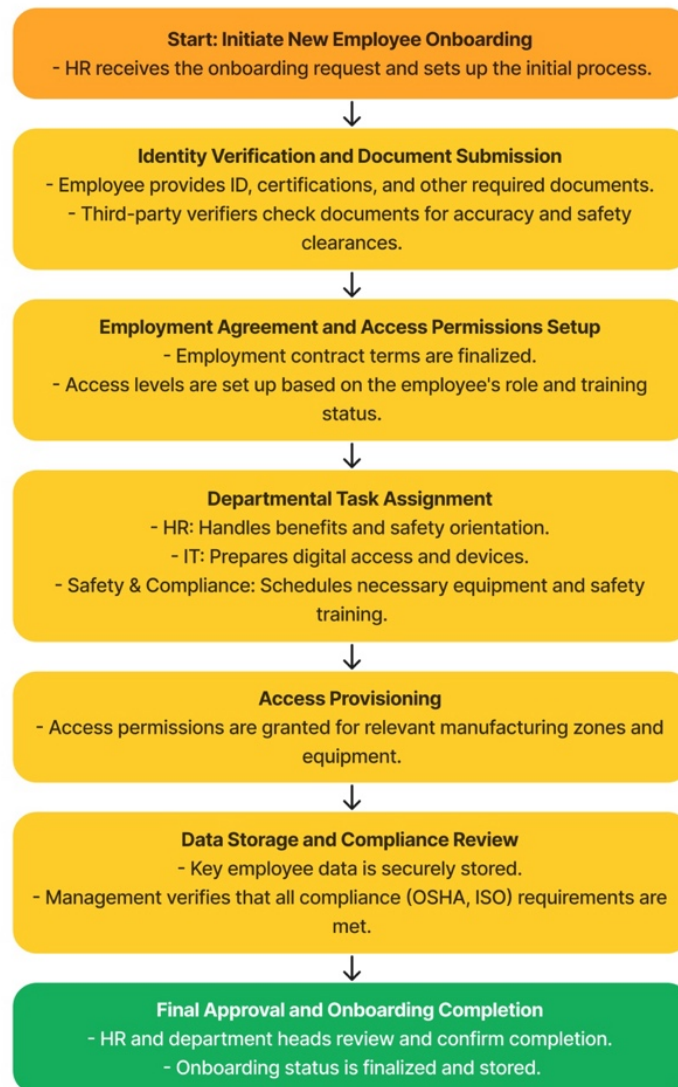


Figure 5.4. Framework of the proposed onboarding module

The final step involves a comprehensive review by the HR and departmental heads to ensure that all onboarding tasks have been completed. Once verified, the onboarding process is formally approved, marking the employee's full integration into the organization. This framework ensures a balance between operational efficiency, regulatory compliance, and employee satisfaction, enabling organizations to effectively onboard new hires while maintaining organizational integrity.

5.4.2. Implementation Framework for Onboarding Workflow

An effective onboarding implementation framework is essential to ensure the structured and efficient integration of new employees into an organization. With the increasing complexities in industries such as manufacturing, where compliance, safety, and operational efficiency are critical, onboarding needs to be streamlined to address these challenges. This framework provides a blueprint for handling diverse onboarding tasks such as identity creation, document verification, and access provisioning. Without a well-defined structure, organizations risk delays, miscommunication, and non-compliance with industry standards, such as OSHA or ISO, which could lead to operational disruptions. Moreover, onboarding sets the tone for an employee's journey within the company, thereby influencing productivity and engagement. By adopting a robust framework, businesses can minimize errors, ensure regulatory adherence, and provide a seamless experience that fosters trust and efficiency from day one.

The implementation framework is pivotal for ensuring operational excellence and compliance within the onboard process. Integrating blockchain technology enhances security and reduces the risk of data breaches while ensuring transparency through decentralized storage. The framework fosters efficiency by automating repetitive tasks, such as document verification and access provisioning, thereby saving time and resources. In addition, it ensures regulatory compliance with industry standards and prevents costly penalties. Real-time monitoring and governance further bolsters oversight, ensuring that onboarding processes remain efficient and error-free. By offering a seamless and structured approach, the framework significantly improves the new hire experience, boosting employee satisfaction and productivity. Ultimately, it aligns organizational goals with workforce readiness, fostering a culture of trust, accountability, and innovation.

Components of Implementation Framework for Proposed Onboarding Module

The framework consisted of multiple interconnected components to ensure comprehensive onboarding. The major components of the implementation framework are as follows:

Decentralized Identity Creation: Employees generate Decentralized Identifiers (DID) on a permissioned blockchain technology. DID is linked to the employee's role and associated access levels (e.g., factory floor and quality control).

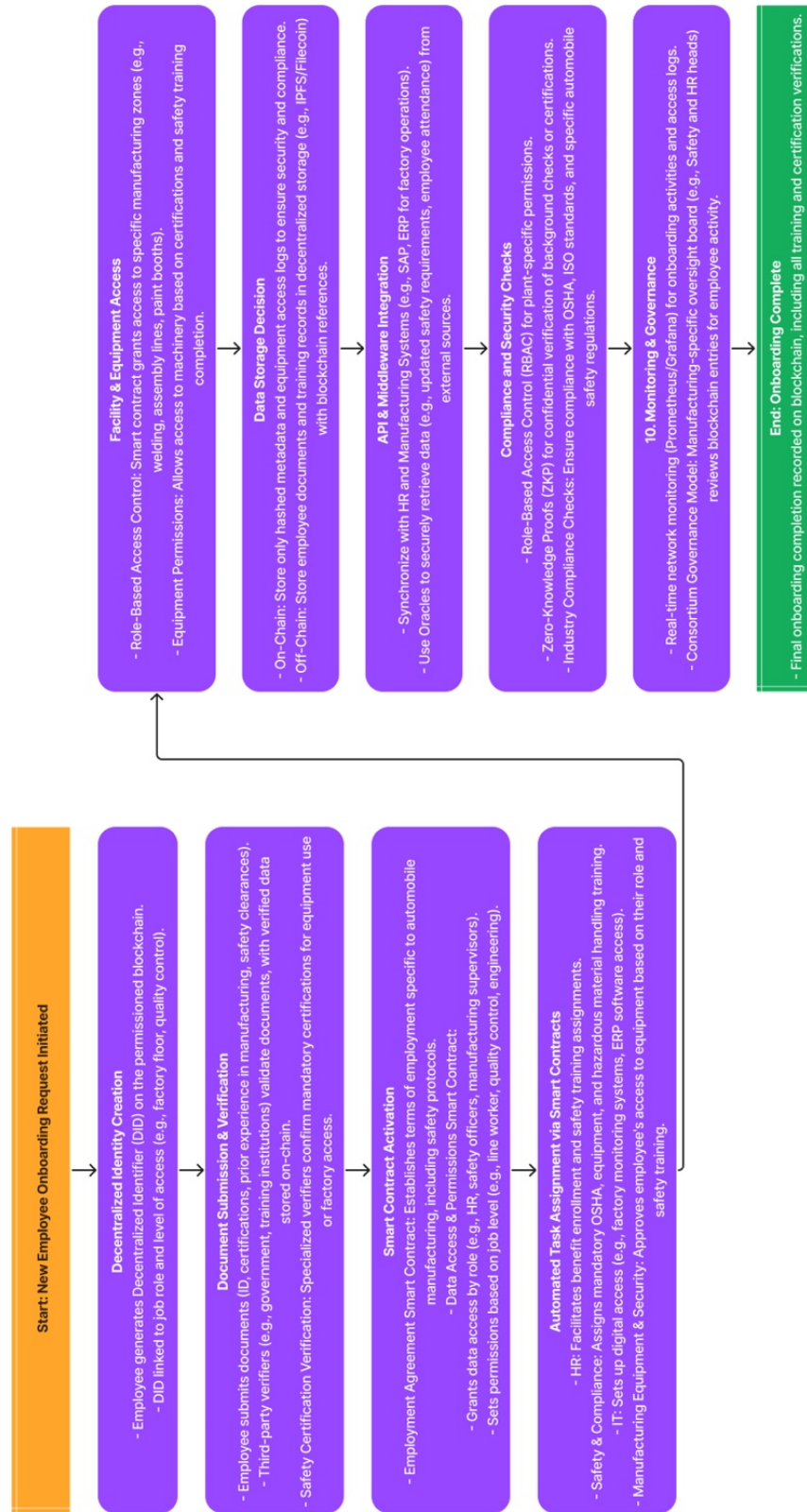


Figure 5.5. Framework for the proposed onboarding module implementation

Document Submission and Verification: Employees submit mandatory documents such as IDs, certifications, and prior work experience records. Verification is conducted by third-party entities and government authorities with securely stored data on the blockchain technology. The verification of safety certification ensures that all safety compliance requirements are met for specific roles or zones.

Smart Contract Activation: Employment Agreement Smart Contracts define employment terms, including safety and operational protocols. Data access and permission smart contracts automatically grant access based on job roles (e.g., HR, safety officers, or manufacturing supervisors). Role-specific permissions are established for secure access to relevant systems and areas.

Automated Task Assignment: Human Resources assigns employee benefits and schedules mandatory safety training. IT teams prepare digital access for factory systems and other technical tools. Safety and Compliance teams ensure employees complete OSHA or hazardous materials handling training. Equipment-specific tasks were assigned based on employee roles and safety training completion.

Facility and Equipment Access: Role-based Access Control is implemented via smart contracts for specific manufacturing areas. Employees gain permissions for machinery usage based on certifications and training status.

Data Storage Decision: On-Chain Storage: Metadata for equipment access logs and permissions is stored securely. Off-Chain Storage: Large documents, such as training certifications, are saved in decentralized storage solutions (e.g., IPFS and Filecoin) with blockchain technology references.

API and Middleware Integration: Synchronizes onboarding processes with external systems such as Human Resource Management Systems (HRMS), ERPs, and safety compliance software. Oracles securely retrieve external data, such as updated certifications or attendance records.

Compliance and Security Checks: Ensures role-based access compliance through RBAC (Role-Based Access Control). Implementing Zero-Knowledge Proofs (ZKP) to validate certifications and training without exposing sensitive data. Conduct industry-standard compliance checks for OSHA, ISO, and manufacturing-specific regulations.

Monitoring and Governance: Real-time monitoring of onboarding activities using tools like Prometheus or Grafana. A consortium-based governance model allows oversight boards (e.g., safety heads or HR executives) to verify all blockchain technology entries for accuracy and compliance.

Working of Implementation Framework for Onboarding Module

The Implementation Framework for the Onboarding Process was designed to streamline employee integration into an organization while ensuring compliance, security, and efficiency. The process begins with Decentralized Identity Creation, where employees generate a unique identifier (DID) using a permissioned blockchain technology. This identifier is tailored to job roles and establishes access level, creating a secure and personalized onboarding pathway. Next, employees submit the necessary documents such as identification, certifications, and work history. Third-party verifiers assess these for authenticity, with all verification data securely stored in the blockchain technology. Specialized checks ensure that safety certifications align with job-specific requirements, thereby guaranteeing compliance with regulatory standards.

Following document verification, Smart Contract Activation formalizes the onboarding agreements. Employment contracts are converted into smart contracts that define the job terms and associated safety protocols. Simultaneously, smart contracts manage data access permissions, granting role-specific access to HR systems, manufacturing zones, or equipment. Automation of these tasks ensures precise access control and reduces human errors and delays. In the next phase, the Automated Task Assignment allocates key responsibilities to the relevant departments. HR facilitates employee enrollment in benefit programs and schedules safety training, while IT teams provide access to digital systems. Safety and Compliance teams oversee the completion of essential training, such as OSHA standards, to ensure readiness for equipment or hazardous material handling.

Once tasks are assigned, Facility and Equipment Access are implemented using role-based access controls enforced by smart contracts. This enables employees to work in specific manufacturing zones and operate equipment to meet training and certification requirements. To maintain data integrity, the framework incorporates a Data Storage Decision mechanism. Metadata and access logs are stored on-chain for security, while larger documents, such as training certifications, are

saved off-chain in decentralized storage systems like IPFS or Filecoin, linked back to the blockchain technology.

The framework seamlessly integrates with external systems through API and Middleware Integration, ensuring real-time synchronization with HR, ERP, and compliance software. Oracles retrieve data such as updated certifications or attendance records to maintain process accuracy. Compliance and Security Checks were conducted at each stage, leveraging Role-Based Access Control (RBAC) and Zero-Knowledge Proofs (ZKP) to validate certifications while preserving confidentiality. The system also adheres to industry regulations such as the OSHA and ISO standards.

Finally, Monitoring and Governance should ensure transparency through real-time tracking tools and oversight boards. Upon completion, the onboarding process is securely recorded on the blockchain technology, marking the employee fully onboard and ready to contribute. This robust framework guarantees an efficient, secure, and compliant onboard experience.

5.5. Proposed Framework of Offboarding Process

The Framework for Offboarding Process is a structured approach designed to ensure seamless, secure, and comprehensive transition for employees exiting an organization. Offboarding is a critical component of the employee lifecycle as it directly affects the organization's compliance, data security, and reputation. A well-designed offboarding framework addresses key aspects, such as access revocation, knowledge transfer, exit formalities, and feedback collection, while maintaining professionalism and respect for the departing employee.

By integrating automation, decentralized technologies, and compliance protocols, the framework safeguards sensitive information and ensures adherence to regulatory standards. Furthermore, it provides valuable insights into employee experiences, enabling continuous improvement of workplace policies and practices. This structured process is essential for minimizing risks, preserving organizational knowledge, and fostering positive relationships with departing employees who may remain valuable ambassadors or collaborators in the future.

5.5.1. Proposed Framework for Offboarding Workflow

The Framework for Offboarding Workflow depicted in Figure 5.6, outlines a systematic approach to managing the departure of employees from an organization, ensuring that the process is efficient, secure, and compliant with organizational policies. This workflow emphasizes critical activities, such as the revocation of access to systems, retrieval of company assets, settlement of dues, and proper documentation. By leveraging structured processes, automation, and role-based protocols, this framework mitigates the risks associated with data breaches, compliance violations, and operational disruptions. Additionally, it focuses on gathering feedback through exit interviews to enhance organizational practices and policies. A well-defined offboarding workflow not only facilitates a smooth transition for both the employee and the organization, but also upholds professionalism, strengthens the employer brand, and fosters lasting positive relationships with departing employees.

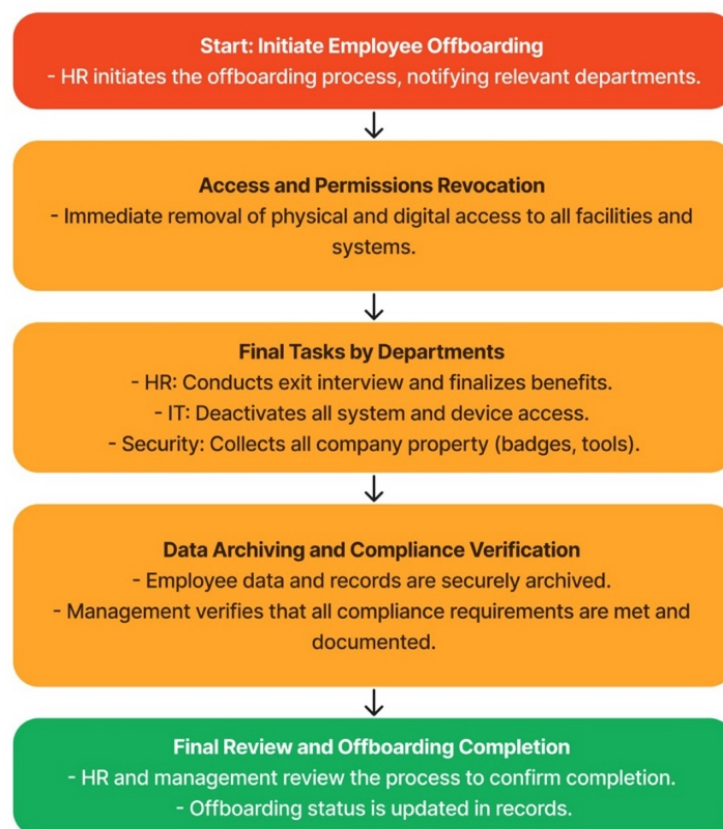


Figure 5.6. Framework of the proposed offboarding module

Components of Framework for Proposed Offboarding Module

This framework outlines a comprehensive approach to offboarding, including access revocation, final tasks by departments, data archiving, compliance verification, and final review. The major components of the proposed offboarding module are as follows.

Initiation and Notification: The offboarding process is initiated by a designated event (e.g., employee resignation or termination). The HR is responsible for notifying relevant departments (IT, Security, Legal, etc.) about offboarding. This ensures coordinated action and the timely execution of tasks.

Access and Permissions Revocation: Upon notification, immediate steps are taken to revoke employees' access to company resources. This includes physical access to buildings, offices, and restricted areas. It involves deactivating access to company systems, networks, applications, and devices (laptops, phones, etc.). This is crucial for safeguarding the sensitive data.

Final Tasks by Departments: HR department conducts exit interviews to gather feedback, finalize benefits, and process outstanding payments. IT department deactivates all system and device access, recovers company-owned equipment, and ensures data security. Security department collects all company properties (badges, tools, etc.) and returns them to the appropriate inventory.

Data Archiving and Compliance Verification: Employee data and records are securely archived in compliance with relevant regulations (e.g., data privacy laws). Management verifies that all compliance requirements related to the offboarding process have been met and documented. This ensures legal and ethical compliance.

Final Review and Offboarding Completion: HR department and management conduct a final review to confirm that all the steps have been completed accurately and in a timely manner. The offboarding status is updated in relevant records such as HR systems and employee databases.

Working of Framework for Proposed Offboarding Module

The proposed offboarding module operates sequentially, ensuring a smooth and secure exit for departing employees. The process begins with HR initiating offboarding and notifying relevant departments, such as IT, Security, and Legal. Subsequently, immediate action is taken to revoke employees' access to both physical and digital resources. This includes deactivating access to

company systems, networks, and devices as well as revoking physical access to buildings and restricted areas. Concurrently, departments undertake their respective tasks. HR conducts exit interviews, finalizes benefits, and processes payments. IT deactivates access, recovers company equipment, and prioritizes data security. Security collects company property and returns it to the inventory.

Subsequently, the module focuses on data archiving and compliance verification. Employee data and records are securely archived in accordance with relevant regulations, while management ensures compliance with all the applicable requirements. Finally, HR and management conduct a final review to confirm the completion of all steps and update the records accordingly. This comprehensive framework ensures a secure and compliant offboarding process, safeguards organizational interests, and maintains a positive image during employee departures.

5.5.2. Implementation Framework for Offboarding Module

The implementation framework for the offboarding module presented in Figure 5.7 outlines a structured approach to integrating ex-employees into the organization using innovative technologies and streamlined processes. The implementation framework for the offboarding module was designed to address the complex and critical requirements associated with managing employee exits in a secure, transparent, and efficient manner. Employee offboarding is a multifaceted process that involves several key activities such as clearance approvals, final settlements, revocation of system access, and knowledge transfer. Traditional offboarding methods often suffer from inefficiencies, lack of coordination, and security vulnerabilities, which can lead to operational disruptions, data breaches, and noncompliance with organizational policies or regulatory mandates. To overcome these challenges, the proposed framework leverages the advanced capabilities of blockchain technology such as decentralized data storage, immutable record-keeping, and automated workflows through smart contracts.

Components of Implementation Framework for Proposed Offboarding Module

This implementation framework leverages the blockchain technology and automation to streamline the offboarding process. It incorporates smart contracts for access revocation, integrates with existing systems, and employs robust security measures, such as zero-knowledge proofs and role-based access control.

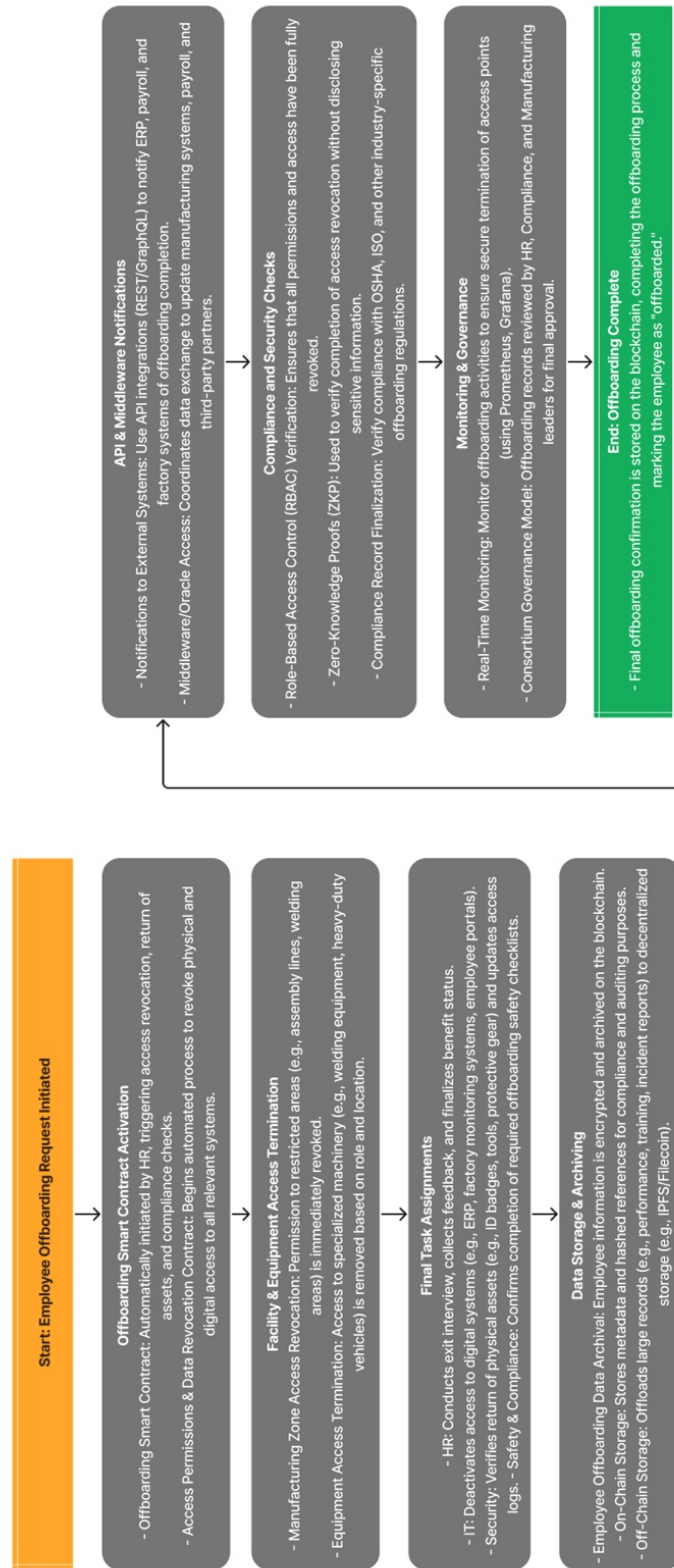


Figure 5.7. Framework of the proposed offboarding module implementation

This framework provides a secure, efficient, and transparent solution for managing employee departure by automating tasks, ensuring compliance with industry standards, and enhancing data security. The major components of the implementation framework for the proposed offboarding module are as follows.

Offboarding Initiation and Smart Contract Activation: The offboarding process is initiated by an employee offboarding request. An offboarding smart contract is automatically activated, triggering the access revocation process and initiating compliance checks.

Access Permissions and Data Revocation: The access permissions and data revocation contract begin an automated process to revoke both physical and digital access to all relevant systems.

Facility and Equipment Access Termination: Permission to restricted manufacturing areas is immediately revoked. Access to specialized machinery and vehicles is removed based on the employee's role and location.

Final Task Assignments: HR department conducts exit interviews, collect feedback, finalize benefit status, and update access logs. IT department deactivates access to digital systems, including ERP, factory monitoring systems, and employee portals. Security department verifies the return of physical assets and updates safety and compliance checklists.

5. Data Storage and Archiving: Employee metadata and hashed references are encrypted and stored in the blockchain technology for compliance and auditing purposes (On-Chain Storage). Large records, such as performance reviews, training records, and incident reports, are stored off-chain in decentralized storage solutions, such as IPFS/Filecoin (Off-Chain Storage).

API & Middleware Notifications: APIs and middleware are used to notify the ERP, payroll, and factory systems of offboarding completion. Middleware/Oracle Access coordinates the exchange of data to update the manufacturing systems, payroll, and third-party partners.

Compliance and Security Checks: All permissions and access have been fully revoked (Role-Based Access Control). Zero-knowledge proofs (ZKP) is used to verify the completion of access revocation without disclosing sensitive information. Compliance record finalization verifies compliance with the OSHA, ISO, and other industry-specific offboarding regulations.

Monitoring & Governance: Real-time monitoring monitors offboard activities to ensure secure termination of access points using tools such as Prometheus and Grafana. Offboarding records are reviewed by HR, Compliance, and Manufacturing leaders for final approval (Consortium Governance Model).

End: Offboarding Complete: Final offboarding confirmation is stored on the blockchain technology, marking the employee as "offboarded."

Working of Implementation Framework for Proposed Offboarding Module

The proposed offboarding module operates on a blockchain technology-based framework, automates key processes, and enhances security. Upon an employee offboarding request, a smart contract is activated, which initiates the access revocation process. This contract automatically provides physical and digital access to company resources, including systems, networks, and devices. Simultaneously, the relevant departments receive automated notifications and undertake assigned tasks. HR conducts exit interviews, finalizes benefits, and updates records. IT deactivates access, recovers company equipment, and ensures data security. Security verifies the return of the company property and updates safety checklists. Employee data are securely archived, with metadata stored on the blockchain technology for compliance and auditing purposes, whereas large records are stored off-chain in decentralized storage.

APIs and middleware facilitate data exchange with other systems, thereby ensuring a smooth transition. Role-based access control and zero-knowledge proofs are implemented to verify access revocation and maintain data privacy. Real-time monitoring tracks offboarding activities and a consortium governance model ensures compliance and approval. Finally, the blockchain technology records the completion of the offboarding process, marking the departure of the employee. This framework streamlines the offboarding process, enhances security, ensures compliance, and provides a transparent and efficient solution for managing employee departure.

5.6. Framework Validation

The proposed blockchain-enabled HR framework was validated using feedback from 10 domain experts, 5 HR professionals and 5 blockchain specialists. A structured questionnaire (Appendix 3)

combined Likert-scale items with open-ended questions to capture both quantitative and qualitative insights.

Table 5.1 presents the summary of expert responses on key validation dimensions. The findings indicate very high agreement on transparency (90%), data security and privacy (80%), and compliance and auditability (80%). Efficiency was also rated positively (70%), reflecting confidence in smart contracts for automating routine tasks. In contrast, agreement levels were lower for integration feasibility (50%) and adoption readiness (40%), highlighting concerns about system compatibility, resource requirements, and organizational preparedness.

Table 5.1. Expert evaluation of the proposed blockchain framework ($n = 10$ experts)

Validation Dimension	Statement (Likert-Scale Item)	% Agree	Mean Score (1–5)
Transparency	The framework improves transparency in onboarding/offboarding processes.	90%	4.6
Security & Privacy	Blockchain enhances data security and privacy in HR records.	80%	4.4
Efficiency	Smart contracts automate tasks effectively, reducing manual workload.	70%	4.1
Compliance & Auditability	The immutable ledger ensures compliance and audit readiness.	80%	4.3
Integration Feasibility	The framework can integrate with existing HRMS systems without major disruption.	50%	3.2
Adoption Challenges	The organization has the skills/resources to implement blockchain HRM systems successfully.	40%	2.9

Scale: 1 = Strongly Disagree, 5 = Strongly Agree

These results are also visualized in Figure 5.8. The chart highlights that while the benefits of blockchain (transparency, security, compliance) are widely recognized, adoption feasibility and integration with legacy systems remain contested areas.

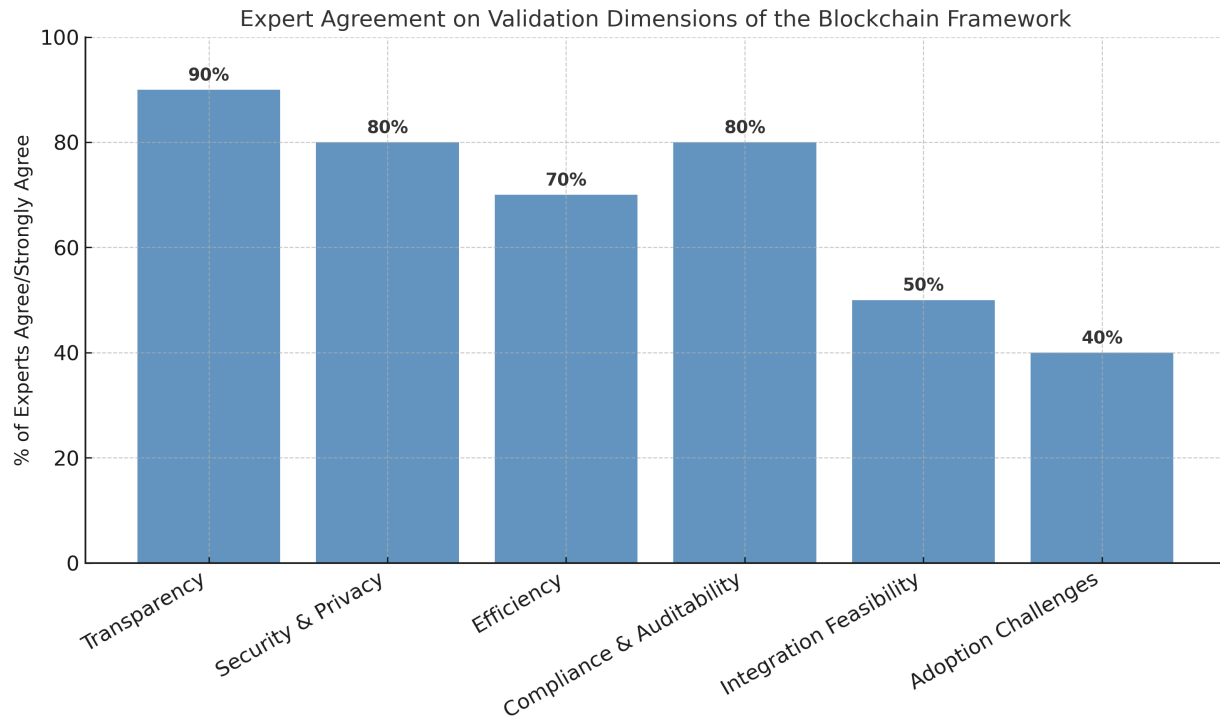


Figure 5.8. Expert agreement on validation dimensions of the blockchain framework

The quantitative findings are consistent with the qualitative feedback received. Experts strongly endorsed the framework’s ability to enhance trust, transparency, and auditability in onboarding and offboarding processes. At the same time, they cautioned that successful implementation would depend on resolving challenges related to technical expertise, budget allocation, and system integration. This dual perspective—optimism about the framework’s value combined with concern about practical constraints—confirms both the promise and the real-world considerations of adopting blockchain in HRM.

5.7. Implementation of Human Resource Onboarding and Offboarding Process Using Blockchain Technology

This section focuses on the practical implementation of a blockchain technology-based framework for human resource onboarding and offboarding processes, utilizing the Remix Ethereum development environment. Remix is a powerful browser-based Integrated Development Environment (IDE) specifically designed for writing, testing, and deploying smart contracts on the Ethereum blockchain technology. By leveraging Remix, this research demonstrates how

blockchain technology can be effectively applied to automate and secure critical HR processes, ensuring transparency, data integrity, and operational efficiency. The Remix platform is described in Chapter 1.

Implementation involves creating and deploying smart contracts to manage employees' onboard and offboarding modules. These contracts handle essential tasks, such as data validation, record creation, and workflow automation, ensuring seamless integration with blockchain technology functionality. Using Remix, the development process includes writing Solidity code, debugging, testing logic, and deploying smart contracts onto a blockchain technology network. This practical approach bridges theoretical concepts and hands-on applications, showcasing how blockchain technology can address the common challenges in HR management.

By integrating blockchain technology with HR processes through the Remix development environment, this study provides a robust and scalable framework for the secure and transparent management of employee lifecycle events. This section explores the implementation steps in detail, highlighting the use of Remix as a user-friendly and efficient tool for developing blockchain technology-based solutions for human resource management.

It is important to note that the blockchain pilot was implemented using Remix IDE's UI-driven deployment environment. As the purpose of this study is HRM-focused, Remix was chosen for its accessibility, enabling smart contract deployment and interaction without the need for manual coding in Solidity. Therefore, no standalone code snippets were generated; instead, the framework validation relied on Remix's built-in blockchain services and user interface.

5.7.1. Coding the Onboarding Module in Remix

In this section, we explore how the onboarding module was coded using Remix IDE for Ethereum smart contract development. The following steps outline the development process for the onboarding module in Remix.

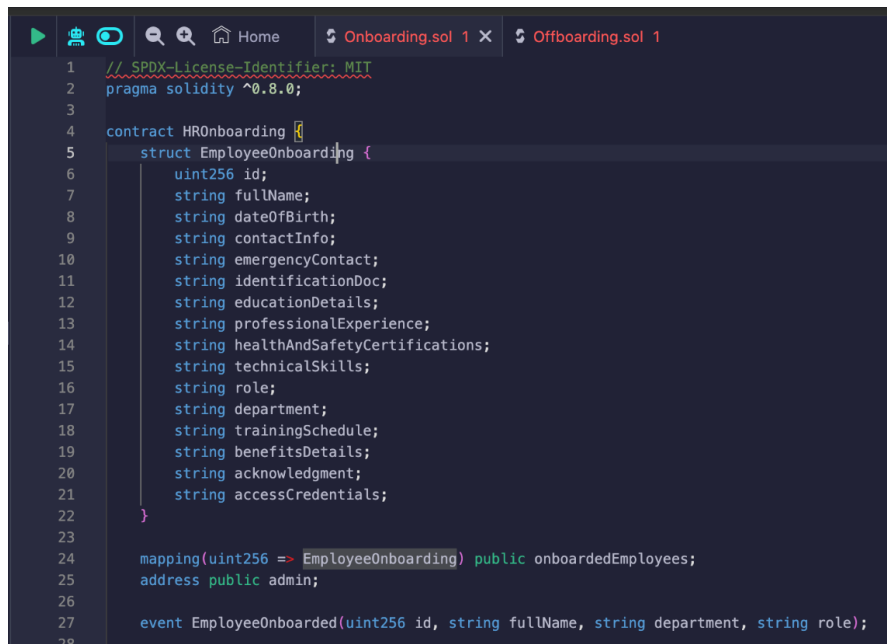
Step 1: Setting Up Remix: Navigate to the Remix Ethereum website (<https://remix.ethereum.org>). Create a new file in the Remix file explorer named Onboarding.sol.

Step 2: Defining the Smart Contract: The first step in the coding defines the structure of a smart contract. For the onboarding module, the onboarding contract is defined by a structure that holds

employee details and a mapping to store the records. The details of this structure are presented in Figure 5.9.

Step 3: Adding Onboarding Functionality: The onboard employee function allows the admin to add new employee data to the blockchain technology. The function uses parameters for the required information and checks for duplicate entries using employee ID. The details of the onboard employee function are shown in Figure 5.10.

Step 4: Retrieving Employee Data: A getter function was added to retrieve employee details based on their ID. This enhances transparency and allows administrators to verify the records when required. The getEmployee function is defined in the Redmix IDE and is depicted in Figure 5.11.



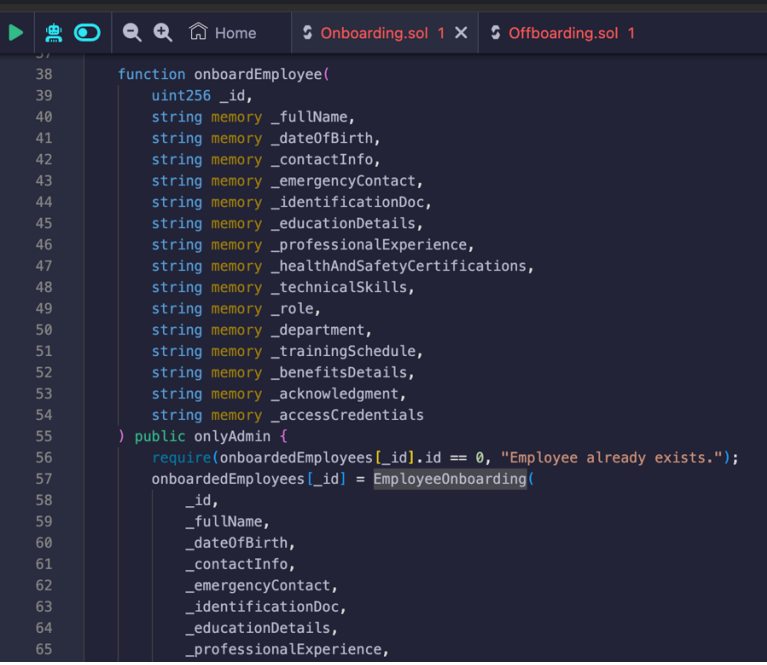
```
1 // SPDX-License-Identifier: MIT
2 pragma solidity ^0.8.0;
3
4 contract HROnboarding {
5     struct EmployeeOnboarding {
6         uint256 id;
7         string fullName;
8         string dateOfBirth;
9         string contactInfo;
10        string emergencyContact;
11        string identificationDoc;
12        string educationDetails;
13        string professionalExperience;
14        string healthAndSafetyCertifications;
15        string technicalSkills;
16        string role;
17        string department;
18        string trainingSchedule;
19        string benefitsDetails;
20        string acknowledgment;
21        string accessCredentials;
22    }
23
24    mapping(uint256 => EmployeeOnboarding) public onboardedEmployees;
25    address public admin;
26
27    event EmployeeOnboarded(uint256 id, string fullName, string department, string role);
28 }
```

Figure 5.9. Onboarding structure on Remix

Step 5: Compiling the Code: Select the Solidity Compiler in Remix and set the appropriate version. For this implementation, Solidity Compiler version 0.8.26 was utilized. The code is compiled to ensure that there are no errors. The details are shown in Figure 5.12.

Step 6: Deploying the Contract: Deploying a smart contract is a critical step in transitioning the onboarding module from code to a functional blockchain technology application. The details of the deployment are discussed in Section 5.6.3.

Step 7: Testing the Contract: Finally, the deployed contract interface in Remix was used to test the onboard Employee and GetEmployee functions. The details of testing the contract are discussed in section 5.6.4.

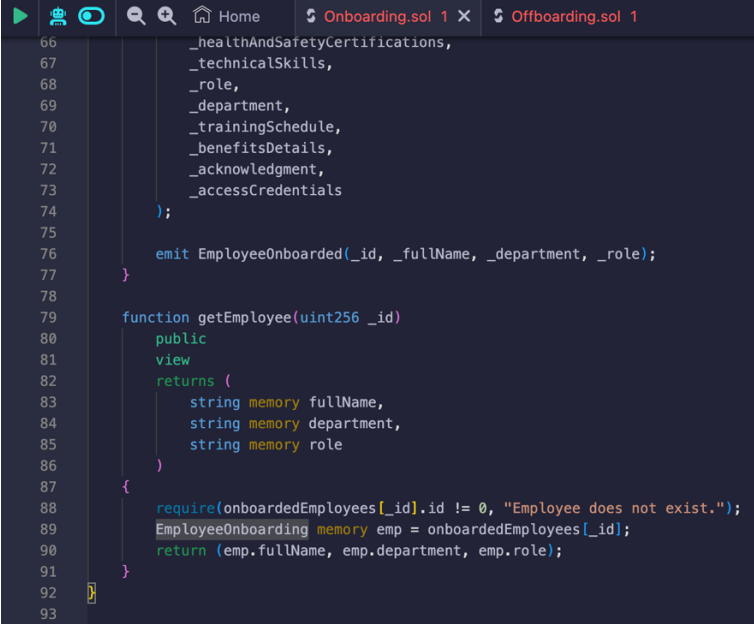


```

37
38     function onboardEmployee(
39         uint256 _id,
40         string memory _fullName,
41         string memory _dateOfBirth,
42         string memory _contactInfo,
43         string memory _emergencyContact,
44         string memory _identificationDoc,
45         string memory _educationDetails,
46         string memory _professionalExperience,
47         string memory _healthAndSafetyCertifications,
48         string memory _technicalSkills,
49         string memory _role,
50         string memory _department,
51         string memory _trainingSchedule,
52         string memory _benefitsDetails,
53         string memory _acknowledgment,
54         string memory _accessCredentials
55     ) public onlyAdmin {
56         require(onboardedEmployees[_id].id == 0, "Employee already exists.");
57         onboardedEmployees[_id] = EmployeeOnboarding(
58             _id,
59             _fullName,
60             _dateOfBirth,
61             _contactInfo,
62             _emergencyContact,
63             _identificationDoc,
64             _educationDetails,
65             _professionalExperience,

```

Figure 5.10. onboardEmployee function on Remix



```

66         _healthAndSafetyCertifications,
67         _technicalSkills,
68         _role,
69         _department,
70         _trainingSchedule,
71         _benefitsDetails,
72         _acknowledgment,
73         _accessCredentials
74     );
75
76     emit EmployeeOnboarded(_id, _fullName, _department, _role);
77 }
78
79     function getEmployee(uint256 _id)
80     public
81     view
82     returns (
83         string memory fullName,
84         string memory department,
85         string memory role
86     )
87     {
88         require(onboardedEmployees[_id].id != 0, "Employee does not exist.");
89         EmployeeOnboarding memory emp = onboardedEmployees[_id];
90         return (emp.fullName, emp.department, emp.role);
91     }
92
93

```

Figure 5.11. getEmployee function on Remix

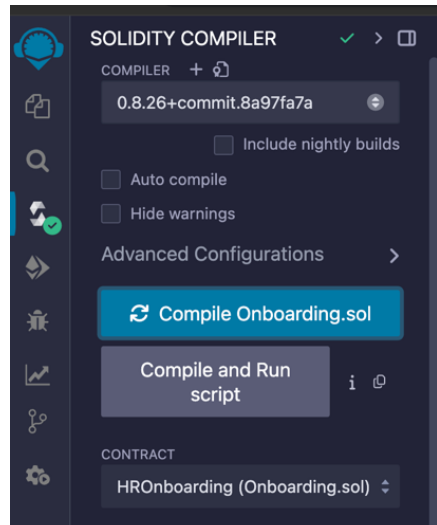


Figure 5.12. Compiling Onboarding.sol on Remix

By utilizing the Remix IDE, an onboarding module was developed and deployed efficiently, enabling a blockchain technology-based HR system tailored to the automobile manufacturing industry. Each employee's data is stored securely on the blockchain technology, ensuring immutability and authenticity. Only authorized administrators can add to or access employee records and safeguard sensitive information. The contract emits events when new employees are onboard, thus providing a transparent record of all actions. The module ensures that onboarding data are recorded transparently and securely, thereby reflecting the potential of blockchain technology in streamlining HR processes.

5.7.2. Coding the Offboarding Module in Remix

In this section, we explore how the offboarding module was coded using Remix IDE for Ethereum smart contract development. The following steps outline the development process for the offboarding module in Remix.

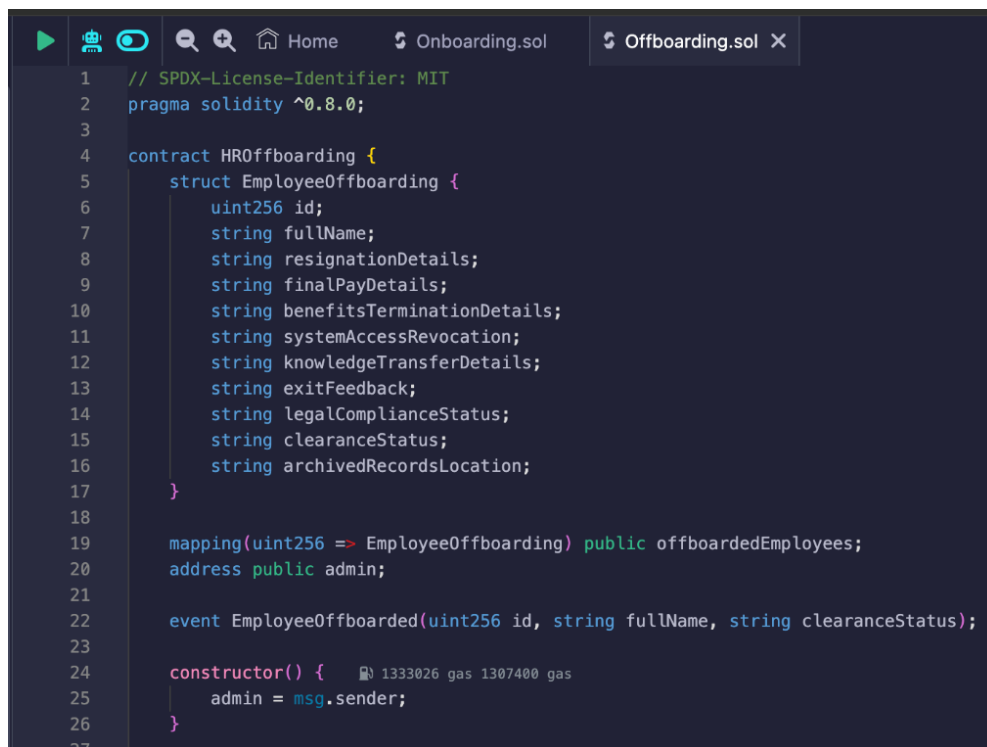
Step 1: Setting Up Remix: Navigate to the Remix Ethereum website (<https://remix.ethereum.org>). Create a new file in the Remix file explorer named Offboarding.sol.

Step 2: Defining the Smart Contract: The first step in the coding defines the structure of a smart contract. For the offboarding module, the offboarding contract is defined by a structure that holds employee details and a mapping to store the records. The details of the structure are shown in Figure 5.13.

Step 3: Adding Offboarding Functionality: The offboard Employee function allows the admin to obtain the ex-employee's data in the blockchain technology. Certain specific rights are provided to admin. Employees' operational rights are available to HR managers. The details of the offboard employee function are shown in Figure 5.14.

Step 4: Retrieving Employee Data: A getter function was added to retrieve employee details based on their ID. The getOffboardEmployee function is used to retrieve the name of the employee and the clearance status of the employee. The getEmployee function is defined in the Redmix IDE and is depicted in Figure 5.15.

Step 5: Compiling the Code: Select the Solidity Compiler in Remix and set the appropriate version. For this implementation, Solidity Compiler version 0.8.26 was utilized. The code is compiled to ensure that there are no errors. The details are shown in Figure 5.16.



```
1 // SPDX-License-Identifier: MIT
2 pragma solidity ^0.8.0;
3
4 contract HROffboarding {
5     struct EmployeeOffboarding {
6         uint256 id;
7         string fullName;
8         string resignationDetails;
9         string finalPayDetails;
10        string benefitsTerminationDetails;
11        string systemAccessRevocation;
12        string knowledgeTransferDetails;
13        string exitFeedback;
14        string legalComplianceStatus;
15        string clearanceStatus;
16        string archivedRecordsLocation;
17    }
18
19    mapping(uint256 => EmployeeOffboarding) public offboardedEmployees;
20    address public admin;
21
22    event EmployeeOffboarded(uint256 id, string fullName, string clearanceStatus);
23
24    constructor() {
25        admin = msg.sender;
26    }
27 }
```

Figure 5.13. Offboarding structure on Remix

```

32
33 function offboardEmployee(    infinite gas
34     uint256 _id,
35     string memory _fullName,
36     string memory _resignationDetails,
37     string memory _finalPayDetails,
38     string memory _benefitsTerminationDetails,
39     string memory _systemAccessRevocation,
40     string memory _knowledgeTransferDetails,
41     string memory _exitFeedback,
42     string memory _legalComplianceStatus,
43     string memory _clearanceStatus,
44     string memory _archivedRecordsLocation
45 ) public onlyAdmin {
46     require(offboardedEmployees[_id].id == 0, "Employee already offboarded.");
47     offboardedEmployees[_id] = EmployeeOffboarding(
48         _id,
49         _fullName,
50         _resignationDetails,
51         _finalPayDetails,
52         _benefitsTerminationDetails,
53         _systemAccessRevocation,
54         _knowledgeTransferDetails,
55         _exitFeedback,
56         _legalComplianceStatus,
57         _clearanceStatus,
58         _archivedRecordsLocation
59     );

```

Figure 5.14. offboardEmployee function on Remix

```

62
63 }
64
65 function getOffboardedEmployee(uint256 _id)    infinite gas
66     public
67     view
68     returns (
69         string memory fullName,
70         string memory clearanceStatus
71     )
72 {
73     require(offboardedEmployees[_id].id != 0, "Employee is not offboarded.");
74     EmployeeOffboarding memory emp = offboardedEmployees[_id];
75     return (emp.fullName, emp.clearanceStatus);
76 }
77

```

Figure 5.15. getOffBoardEmployee function on Remix

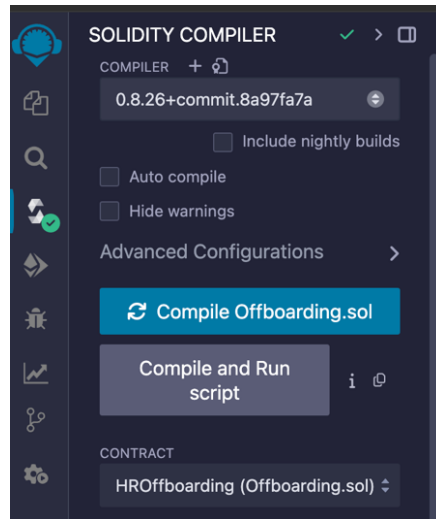


Figure 5.16. Compiling Offboarding.sol on Remix

Step 6: Deploying the Contract: Deploying a smart contract is a critical step in transitioning the offboarding module from code to a functional blockchain technology application. The details of the deployment are discussed in Section 5.6.3.

Step 7: Testing the Contract: Finally, the deployed contract interface in Remix was used to test the offboard Employee and getOffBoardEmployee functions. The details of testing the contract are discussed in section 5.6.4.

By utilizing the Remix IDE, an offboarding module was developed and deployed efficiently, enabling a blockchain technology-based HR system tailored to the automobile manufacturing industry. Each employee's data is stored securely on the blockchain technology, ensuring immutability and authenticity. Only authorized administrators can add to or access employee records and safeguard sensitive information. HR managers can access data related to offboarding. The contract emits events when ex-employees are offboarded, thus providing a transparent record of all actions. The module ensures that offboarding data are recorded transparently and securely, thereby reflecting the potential of blockchain technology in streamlining HR processes.

5.7.3. Deploying the Smart Contracts on Blockchain Technology

Deploying smart contracts tailored to both onboarding and offboarding data for the automobile manufacturing industry ensures the secure and systematic management of employee lifecycle events on the blockchain technology. The process begins by compiling two distinct contracts in

the Remix IDE: onboarding and offboarding. The deployment details of Onboarding and Offboarding are shown in Figure 5.17. These contracts are designed to capture comprehensive onboarding details, such as personal information, identification, education, professional experience, health and safety certifications, technical skills, and role-specific details for new hires. Simultaneously, the offboarding contract is structured to manage exit documentation, final pay and benefits, system access revocation, knowledge transfer, exit interviews, legal compliance, and record retention for departing employees.

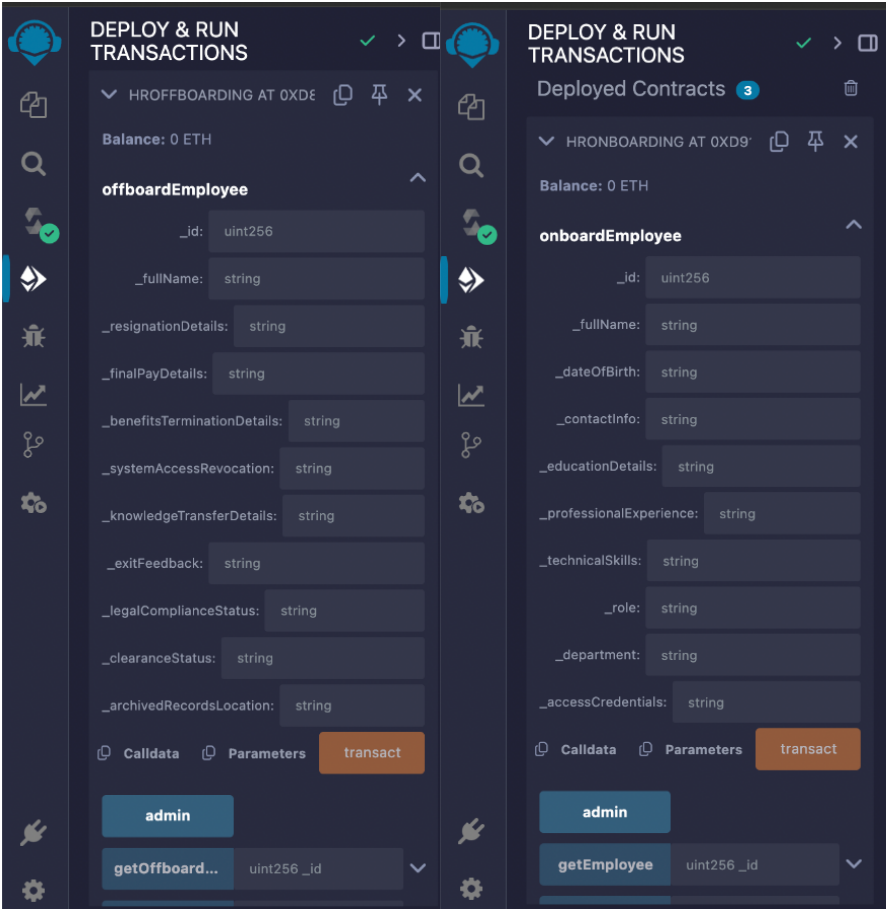


Figure 5.17. Deployment details of onboarding and offboarding module

Once compiled without errors, the contracts are deployed to a suitable blockchain technology environment, such as the JavaScript VM for testing or an Ethereum test network, such as Ropsten. Each contract receives a unique blockchain technology address that facilitates secure interactions with its respective functions. HR administrators utilize these addresses to securely add and manage employee data throughout their lifecycle, from the initial onboarding details to the final

offboarding procedures. Events were emitted during deployment and subsequent interactions to confirm the successful recording and management of employee data across both modules.

This deployment process ensures transparency, immutability, and compliance with organizational and regulatory standards throughout the employee lifecycle. By leveraging blockchain technology, deployment facilitates efficient and secure HR operations within the automobile manufacturing industry, enhancing data integrity and operational efficiency across onboarding and offboarding processes.

5.7.4. Testing of Smart Contracts

Testing smart contracts for HR onboarding and offboarding processes in the automobile manufacturing industry is a critical step to ensure their functionality, security, and compliance with regulatory standards. This section details the methodologies and procedures employed to verify the robustness and correctness of the HROnboarding and HROffboarding contracts developed using Remix IDE.

Unit Testing: Unit testing focuses on verifying individual functions within a smart contract. Using the Remix IDE's testing capabilities, specific functions such as onboard Employee and Offboard Employee undergo rigorous testing with varied inputs. This ensures that each function correctly handles data inputs, executes business logic accurately, and emits expected events, thereby validating its isolated behavior.

Integration Testing: Integration testing evaluates how different parts of smart contracts interact with each other and external components. Test scenarios were designed to validate the flow of data between the HROnboarding and HROffboarding contracts, ensuring seamless integration during employee lifecycle events. This testing phase identifies and resolves any inconsistencies or dependencies that may arise from the interactions between contract modules.

In conclusion, rigorous testing of Onboarding and Offboarding smart contracts is essential to ensure their reliability, security, and compliance in managing HR processes in the automobile manufacturing industry. By employing comprehensive testing methodologies, organizations can leverage blockchain technology to enhance transparency, efficiency, and data integrity across the employee lifecycle management, thereby optimizing HR operations and ensuring regulatory compliance.

5.8. Comparison of Proposed Framework with State-of-the-Art Frameworks

The proposed blockchain technology-based HR onboarding and offboarding frameworks present a significant advancement over state-of-the-art frameworks in the domain of human resource management. Traditional frameworks often rely on centralized databases and manual processes, which are susceptible to inefficiencies, security vulnerabilities, and data manipulation risks. This section provides a comparative analysis between the proposed blockchain technology-enabled framework and existing HR frameworks, highlighting their distinct advantages in terms of security, transparency, automation, and compliance. The comparison was based on metrics such as data security and integrity, transparency, automation, scalability, compliance, and auditability.

Table 5.2 compares the proposed blockchain technology-based HR onboarding and offboarding frameworks with the four existing blockchain technology-based frameworks in various management subfields. This comparison highlighted the unique features and applications of each framework.

Table 5.2. Comparison of the proposed framework with existing frameworks

Comparison Metric	Proposed Framework	HR	Supply Chain Quality Management Framework (Tian, 2017)	Healthcare Records Management Framework (Omar et al., 2019)	Digital Asset Management Framework (Zhang et al., 2018)	Cross-Organizational Project Management Framework (Li et al., 2022)
Primary Focus	Onboarding and offboarding of employees in the automobile manufacturing industry		Enhancing quality control and transparency in supply chains	Secure management of electronic health records (EHR)	Secure management of digital assets	Facilitating cross-organizational project management using Gantt charts
Blockchain Platform	Hyperledger		Ethereum	Not specified	Not specified	Hyperledger Fabric
Smart Contracts	Automates HR processes such as document verification, data storage, and compliance checks		Automates quality control processes and ensures product authenticity	Manages patient consent and data sharing	Utilizes smart contracts for asset transactions and access control	Implements smart contracts for project task assignments and tracking
Consensus Mechanism	PBFT (Practical Byzantine Fault Tolerance) for secure and fast transaction validation		PoW (Proof of Work) or PoS (Proof of Stake), depending on	Not specified	Not specified	Not specified

		the implementation			
Transparency	Provides real-time visibility into HR data for employees, HR managers, and system administrators	Enables stakeholders (suppliers, manufacturers, retailers) to track goods in real-time	Allows authorized access to patient records	Ensures transparent tracking of digital asset ownership	Provides visibility into project timelines and task progress for all stakeholders
Data Security	Decentralized storage and cryptographic security to prevent data breaches	Ensures tamper-proof and immutable records of transactions	Protects patient data through encryption and access controls	Secures digital assets with encryption and blockchain technology immutability	Secures project data and ensures integrity through blockchain technology
Scalability	Designed to handle high volumes of employee data and onboarding/offboarding transactions	Capable of managing a large number of transactions across supply chain nodes	Scalable to accommodate large numbers of patient records	Designed to manage a vast array of digital assets	Supports large-scale project management across multiple organizations
Regulatory Compliance	Aligns with labor laws, GDPR, and other data protection regulations	Adheres to trade regulations, import/export compliance, and quality standards	Complies with healthcare regulations such as HIPAA	Ensures compliance with digital rights management laws	Facilitates compliance with project management standards and contractual obligations
Auditability	Immutable ledger records facilitate easy HR audits and compliance checks	Provides verifiable records of product origins and transaction history	Enables audit trails of patient data access and modifications	Maintains an immutable record of asset transactions for auditing purposes	Offers an auditable history of project activities and decisions
Automation Scope	Automates HR functions, including system access provisioning and termination	Automates inventory tracking, payment settlements, and supplier evaluation	Automates patient consent management and data sharing processes	Automates asset transfers, licensing, and access management	Automates task assignments, progress tracking, and inter-organizational collaboration
Stakeholders Involved	Employees, HR managers, system administrators	Manufacturers, suppliers, retailers, logistics providers	Patients, healthcare providers, insurance companies	Content creators, distributors, consumers	Project managers, team members, organizational leaders
Key Benefits	Enhances HR efficiency, ensures compliance, and improves data security	Reduces fraud, enhances product traceability, and ensures faster contract settlements	Improves patient data security, facilitates seamless data sharing, and enhances trust in healthcare systems	Protects intellectual property, streamlines asset management processes, and reduces piracy	Enhances coordination, improves project transparency, and increases efficiency in project execution

The comparison table highlights the distinct features and applications of the proposed blockchain technology -based HR onboarding and offboarding frameworks, in contrast to the existing blockchain technology frameworks in other management subfields. The proposed framework is specifically tailored for the automobile manufacturing industry, focusing on streamlining and securing employee data management during the onboarding and offboarding processes. Unlike frameworks such as the supply chain quality management system or healthcare records management framework, the HR framework utilizes Hyperledger and PBFT consensus mechanisms to ensure high data security, compliance with regulations, and auditability.

While the supply chain framework emphasizes product traceability and fraud prevention, the HR framework automates employee lifecycle management tasks including document verification, system access provisioning, and termination. Similarly, the healthcare framework prioritizes secure patient data sharing, whereas the HR framework centers on role-specific data, health and safety compliance, and IT access. Compared to digital asset and project management frameworks, which focus on asset ownership and inter-organizational collaboration, the HR framework provides transparency and automation specific to employee lifecycle management.

The table demonstrates how each framework aligns with the unique needs of its domain, highlighting the versatility of blockchain technology in addressing the challenges across diverse management fields. The proposed framework stands out for its focus on enhancing HR operational efficiency, improving data security, and ensuring compliance with labor and data protection regulations.

5.9. Summary

This chapter explores the integration of blockchain technology into HR processes, specifically focusing on onboarding and offboarding in the automobile manufacturing sector. It presents a structured framework designed to enhance operational efficiency, data security, and compliance with labor and data protection regulations. The proposed system utilizes a flow diagram to illustrate the various components and their interdependencies, facilitating a clear understanding of stakeholders, such as HR managers, system architects, and IT specialists. The implementation process is detailed in a series of steps, including code compilation, contract deployment, and

testing using the Remix IDE. Each step is crucial for transitioning the offboarding module from a theoretical code to a functional blockchain technology application, ensuring that employee data are securely stored and accessible only to authorized personnel. The framework emphasizes the importance of transparency and automation in managing the employee lifecycle, addressing the unique challenges faced in HR management. This chapter highlights the versatility of blockchain technology in improving HR processes, ensuring data integrity, and fostering a secure environment for managing sensitive employee information. By adopting this innovative approach, organizations can achieve greater alignment with their operational goals and enhance their overall HR management practices.

Chapter 6: Conclusion and Future Scope of Research

The final chapter encapsulates the key findings of the research, emphasizing its significance in addressing contemporary challenges within HRM through the integration of blockchain technology. It provides a comprehensive summary of the study's contributions, highlighting how the proposed framework enhances efficiency, security, and transparency in HRM processes, such as onboarding and offboarding. Additionally, this chapter reflects on the limitations encountered during the research and explores potential areas for further investigation. By identifying opportunities for technological advancement and broader application, this section outlines a forward-looking perspective that encourages the continuous evolution of blockchain technology-enabled HR practices.

This chapter is divided into two sections: Section 6.1 provides the conclusions of each chapter. Section 6.2 provides the limitations and future work of this research.

6.1. Conclusions

Chapter 1 underscores the critical foundations laid for the subject, weaving together key discussions and insights into a cohesive summary. By revisiting the primary themes and objectives explored, this closing section not only consolidates the knowledge presented, but also paves the way for future exploration in subsequent chapters. Central to the discourse in this chapter is the emphasis on the intricate interplay between theoretical frameworks and practical applications. This dual perspective serves as a foundation for the subject, highlighting its relevance across diverse contexts. Through a careful examination of the historical evolution of ideas and their contemporary significance, this chapter establishes a bridge that links foundational concepts to emerging trends and challenges in the field. Moreover, this chapter delves into the complexities of the topic by addressing its multifaceted dimensions, ensuring a comprehensive understanding of the reader. By dissecting various perspectives, the discussion not only enriches the narrative but also fosters critical thinking, encouraging readers to engage with the material more actively. The integration of real-world examples serves to anchor theoretical discussions and adds a layer of practical relevance to the text. The challenges and opportunities highlighted throughout the chapter provide a balanced view of this subject. By acknowledging these limitations and potential pitfalls, the analysis gains credibility and depth, preparing readers to approach the field from a nuanced

perspective. Simultaneously, the emphasis on opportunities underscores the topic's dynamic nature, inspiring further inquiry and innovation. This chapter achieves its objective of laying a solid foundation for the reader, equipping them with the necessary tools to navigate the complexities of the subject.

Chapter 2 comprehensively examines the role of blockchain technology in enhancing human resource management, particularly in critical areas of onboarding and offboarding. The analysis highlights the potential advantages of blockchain technology, such as improved transparency, heightened security, and increased efficiency, which collectively address the longstanding challenges within HR practices. Furthermore, the review of the existing literature underscores significant gaps that warrant further investigation, emphasizing the need for empirical research to substantiate theoretical claims and practical applications. The systematic bibliometric analysis conducted herein not only provides a robust foundation for understanding the current landscape of blockchain technology in HRM but also catalyzes future studies aimed at exploring innovative solutions in this field. As organizations continue to navigate the complexities of workforce management in the digital age, the integration of blockchain technology presents an opportunity to transform traditional HR processes. By leveraging these advancements, organizations can ensure a more streamlined and resilient employee lifecycle, ultimately fostering a more productive and engaged workforce. Future research should focus on the application and effectiveness of blockchain technology within various organizational contexts to fully realize its potential benefits and drive further innovation in human resource management.

Chapter 3 concludes the research by synthesizing its key findings, reflecting on the contributions made, and outlining the scope of future work. It reiterates how the study bridges the gap between traditional HRM practices and innovative blockchain technology-based solutions, particularly in the context of onboarding and offboarding processes in the automobile manufacturing sector. By addressing critical challenges, such as inefficiencies, lack of transparency, and data security vulnerabilities, this research demonstrates the transformative potential of blockchain technology in HRM. The proposed blockchain technology framework integrates the principles of decentralization, immutability, and transparency, thereby offering a robust solution to modern HR challenges. Through the practical application of Ethereum smart contracts, this study establishes a secure tamper-proof mechanism for managing sensitive employee lifecycle data. This contribution

is particularly relevant in industries, such as automobile manufacturing, where compliance, precision, and efficiency are paramount. The methodology adopted—spanning bibliometric analysis, semi-structured interviews, thematic data analysis, and blockchain technology implementation—ensured that the study remained both academically rigorous and practically applicable. While this study offers significant insights and a working blockchain technology framework, it acknowledges certain limitations. This research is geographically focused on the Punjab region, limiting the generalizability of its findings to other regions or industries. Furthermore, the use of purposive sampling, although effective for capturing context-specific insights, introduces a potential selection bias. Despite these constraints, this study provides a solid foundation for further exploration, especially for enhancing HRM practices with emerging technologies. The future scope for research includes the exploration of blockchain technology interoperability with existing HR systems, incorporation of artificial intelligence for predictive HR analytics, and evaluation of blockchain technology-based HR frameworks in diverse industrial contexts. Additional studies could also investigate the scalability of the proposed solution and its adaptability to evolving technological and regulatory landscapes. Furthermore, the blockchain technology framework can be expanded to include other HR functions such as performance management, payroll systems, and employee engagement initiatives.

Chapter 4 highlights the transformative role of data analysis in converting raw data into actionable insights, emphasizing a systematic approach that integrates advanced tools and methodologies. By employing Python and its extensive library ecosystem, this research effectively navigated complex datasets, ensuring both scalability and precision. The strategic use of libraries like pandas, matplotlib, NLTK, and TextBlob has streamlined processes ranging from data preprocessing to sentiment and thematic analysis. Through thematic analysis, key patterns within textual data were uncovered, offering a nuanced understanding of the challenges and opportunities within HR onboarding and offboarding practices. The inclusion of sentiment analysis further enriches these findings by revealing stakeholders' emotional responses, which are instrumental in guiding organizational decision making. These analyses collectively underscored the potential of blockchain technology to address inefficiencies, enhance data security, and improve procedural transparency in HR processes. The chapter also details the significant challenges faced by traditional onboarding and offboarding mechanisms, such as inconsistent protocols, knowledge retention issues, and delays in data processing. Content analysis quantified these issues and

provided statistical support to the qualitative observations. The findings demonstrate a compelling case for the integration of blockchain technology as it addresses these challenges by offering robust solutions for secure data management, transparent transactions, and immutable record-keeping. Moreover, the analysis revealed a predominantly positive sentiment toward blockchain technology adoption, tempered by concerns about implementation costs and resource requirements. This indicates that readiness among stakeholders to embrace technological innovation, provided organizational support, and infrastructure is in place.

Chapter 5 thoroughly examines the integration of blockchain technology into HR onboarding and offboarding processes, particularly in the context of the automobile manufacturing sector. The proposed framework was designed to address the inherent challenges faced by traditional HR systems, such as data security vulnerabilities, inefficiencies in workflow management, and compliance issues with labor regulations. By leveraging the unique attributes of blockchain technology, namely its transparency, immutability, and decentralized nature, the framework aims to create a robust and reliable HR management system. The conceptual framework presented serves as a foundational blueprint that illustrates the critical components and relationships that underpin the proposed solution. It emphasizes the flow of data from the initial capture through processing to the outcomes, ensuring that all stakeholders, including HR managers and IT specialists, can understand the system's functionality and interdependencies. This clarity is essential for fostering collaboration and ensuring that implementation aligns with organizational goals. Moreover, the chapter outlines a detailed implementation strategy that encompasses technological, procedural, and organizational considerations. This roadmap is crucial for guiding organizations through the transition from conventional HR practices to a blockchain technology - enabled environment. It includes steps, such as defining smart contracts, coding functionalities, and establishing security measures to protect sensitive employee information. Each phase of the implementation process is meticulously detailed to ensure that organizations can effectively deploy the system while minimizing disruptions to existing operations. The emphasis on automation and transparency within the proposed framework not only enhances operational efficiency but also builds trust among employees and management. By ensuring that all transactions are recorded on a tamper-proof ledger, organizations can foster a culture of accountability and integrity. Additionally, the framework's alignment with data protection regulations ensures that organizations remain compliant while managing employee information.

Taken together, the findings across chapters converge on two central insights. First, blockchain offers clear value in addressing inefficiencies, security concerns, and transparency gaps in onboarding and offboarding, as consistently highlighted through thematic, content, and sentiment analyses. Second, enthusiasm is tempered by pragmatic concerns about cost, integration, and organizational readiness, which surfaced both in expert validation and in participant reservations. This duality highlights that blockchain in HRM is not simply a technological upgrade but a socio-technical shift requiring alignment between process redesign, resource investment, and cultural acceptance. By triangulating qualitative evidence, expert validation, and a pilot demonstration, this research makes both a theoretical contribution - demonstrating how blockchain reshapes trust and compliance mechanisms in HRM - and a practical one, by providing a framework that organizations can adapt once technical and organizational conditions are met.

To complement the narrative synthesis presented above, a consolidated numerical summary of the research findings is provided in Table 6.1. This table integrates results across all chapters, combining both qualitative insights and quantitative indicators, and highlights the key deliverables of the study. The purpose of this summary is to offer a concise, at-a-glance overview of the study's contributions and outcomes.

Table 6.1. Consolidated Summary of Research Findings and Deliverables

Research Stage / Method	Core Results / Findings	Quantitative Indicators	Key Deliverables
Bibliometric Analysis (Ch. 2)	Identified limited integration of blockchain with HR onboarding/offboarding; research dominated by international studies.	Dataset: 137 studies (2010–2024); keyword cluster gap (blockchain ↔ onboarding/offboarding weak link).	Evidence of research gap in HR-blockchain lifecycle studies.
Qualitative Data Collection (Ch. 3–4)	HR experts highlighted inefficiencies in onboarding (standardization, role clarity) and offboarding (exit interviews, knowledge loss).	n = 48 participants (Punjab automobile sector).	Primary dataset; validated interview protocol;

			codebook of 4 themes.
Thematic Analysis (Ch. 4)	Four themes: (1) Issues with Onboarding, (2) Issues with Offboarding, (3) Need for Blockchain in Onboarding, (4) Need for Blockchain in Offboarding.	4 stable themes supported by >30 unique codes.	Empirically grounded thematic map with participant quotes.
Content Analysis (Ch. 4)	Frequent terms linked to verification, secure storage, compliance, and knowledge transfer.	Top keywords: “verification” (62 mentions), “secure data” (55), “knowledge transfer” (41).	Frequency table (Table 4.2) supporting blockchain relevance.
Sentiment Analysis (Ch. 4)	Overall positive sentiment toward blockchain, with neutral caution and negative concerns about costs/skills.	Positive (68%), Neutral (20%), Negative (12%) – Figure 4.5.	Sentiment distribution chart + coding framework.
Framework Design (Ch. 5)	Conceptual + architectural model for blockchain-based HR onboarding/offboarding.	Input: onboarding/offboarding data; Output: immutable employee blocks.	Proposed blockchain-enabled HRM framework.
Pilot Implementation (Ch. 5)	Framework prototyped using Remix IDE (Ethereum).	Contracts tested with sample onboarding/offboarding cases.	Proof-of-concept demonstration.
Expert Validation (Ch. 5)	Strong support for transparency, security, auditability; concerns on adoption/integration.	n = 10 experts (5 HR + 5 blockchain); Likert summary: Transparency 90%, Security 80%, Adoption feasibility 40%.	Validation report

6.2. Limitations and Future Scope

The integration of blockchain technology into HRM presents numerous opportunities for further research and practical application. While this study focuses on enhancing the onboarding and offboarding processes in the automobile manufacturing sector, the potential of blockchain technology extends beyond these specific functions, offering a wide range of possibilities for future exploration. This section outlines the future scope of research and development, emphasizing the technological, organizational, and academic dimensions of blockchain technology-based HRM systems.

Expanding Blockchain Technology Applications in HRM: Future research can explore how blockchain technology can be extended to other HR functions such as payroll management, performance evaluation, employee engagement, and succession planning. Blockchain technology's immutability and transparency can streamline payroll processes by ensuring accurate and timely payments while maintaining a tamper-proof record of transactions. Similarly, integrating blockchain technology into performance evaluation systems can provide an unbiased and auditable mechanism for tracking employees' contributions and achievements. Expanding these applications will enable a holistic transformation of HR operations and address inefficiencies across the employee lifecycle.

Enhancing Interoperability with Existing HR Systems: A critical challenge in implementing blockchain technology-based HRM frameworks is the integration of legacy systems and existing enterprise resource planning (ERP) platforms. Future work could focus on developing middleware solutions and APIs to facilitate seamless interoperability. These advancements will allow organizations to transition to blockchain technology-based systems without disrupting their ongoing operations. Additionally, exploring the integration of blockchain technology with other emerging technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), can further enhance automation, decision-making, and operational efficiency in HR processes.

Addressing Scalability and Performance Issues: As the volume of HR data increases, blockchain technology networks must be capable of handling high transaction volumes without compromising speed or efficiency. Future research can investigate the use of advanced consensus mechanisms, such as Proof of Stake (PoS) or Practical Byzantine Fault Tolerance (PBFT), to improve blockchain technology scalability while maintaining security. Layer two solutions, such

as side chains or off-chain processing, can also be explored to optimize the performance of large-scale HR applications in industries with complex and dynamic workforces.

Blockchain Technology for Global Workforce Management: With the rise of globalization, organizations are increasingly managing diverse and geographically dispersed workforces. Blockchain technology can play a pivotal role in standardizing HR practices across borders, ensuring compliance with various regulatory requirements, and facilitating seamless employee mobility. Future research could examine the potential of blockchain technology in managing cross-border payroll, international tax compliance, and global employee benefits, addressing the complexities of operating in a globalized environment.

Improving Data Privacy and Compliance: As data privacy regulations become more stringent worldwide, the role of blockchain technology in ensuring compliance with laws such as GDPR and CCPA can be further explored. Future work can focus on enhancing privacy-preserving techniques such as zero-knowledge proofs and secure multiparty computation to ensure that sensitive employee data remain confidential while being verifiable. This research direction will help organizations strike a balance between transparency and privacy, fostering trust among employees and stakeholders.

Real-world implementation and Case Studies: While this study demonstrates a conceptual framework for blockchain technology-based onboarding and offboarding, future research could focus on real-world implementation and case studies across various industries. By analyzing the practical challenges and benefits of blockchain technology adoption in different organizational contexts, researchers can refine existing frameworks and develop industry-specific solutions. Comparative studies across sectors such as healthcare, finance, and manufacturing can provide valuable insights into the adaptability and scalability of blockchain technology in HRM.

Leveraging Predictive Analytics with Blockchain Technology: Integrating predictive analytics with blockchain technology can revolutionize HR decision-making. By securely storing and analyzing employee data, organizations can predict workforce trends, assess training needs, and identify potential risks such as high turnover rates. Future research can delve into combining blockchain technology-based data storage with machine learning algorithms to enhance strategic workforce planning and improve organizational resilience.

Sustainability and Energy Efficiency in Blockchain Technology -Based HRM: As organizations increasingly prioritize sustainability, future research should focus on developing energy-efficient blockchain technology solutions for HRM. The adoption of green blockchain technologies and consensus mechanisms with lower energy consumption, such as the Proof of Authority (PoA), can make blockchain technology more environmentally friendly. This aligns with the growing emphasis on corporate social responsibility and sustainable business practices.

Policy and Governance Implications: The adoption of blockchain technology in HRM raises important questions about governance, legal frameworks, and organizational policies. Future studies could explore the development of standardized protocols and governance models to regulate blockchain technology-based HR systems. Additionally, research can address ethical considerations, such as the potential misuse of blockchain technology data or the implications of automating HR processes, to ensure that technological advancements align with ethical and legal standards.

Blockchain Technology for Employee Empowerment and Engagement: The decentralized nature of blockchain technology offers unique opportunities for empowering employees by giving them greater control over their data. Future research can investigate the development of self-sovereign identities in which employees manage their credentials and professional records independently. This can foster trust and transparency between employees and organizations and enhance engagement and satisfaction.

User Interaction & Experience: Future research should extend beyond backend feasibility to the design and testing of user-facing modules, such as HR manager dashboards and employee self-service portals. These components are essential for ensuring usability, adoption, and overall experience, but were outside the scope of the present HRM-centric pilot study. Collaborations with blockchain developers and UI/UX specialists will be necessary to transform the conceptual framework into a fully interactive application that can be seamlessly integrated into organizational HR workflows.

Adoption Readiness & Implementation: While this thesis demonstrates the feasibility of blockchain in HR onboarding and offboarding through expert validation and a pilot study, full organizational adoption requires further work. Technical refinement, system integration, change-management strategies, and dedicated funding are essential preconditions for deployment at scale.

As this study is rooted in HRM, these aspects fall outside its scope but provide clear directions for collaboration with computer science and engineering researchers. The present framework can also serve as a basis for future funding proposals, enabling resource mobilization and industry partnerships that will support translation into practice.

Future research should also move beyond broad conceptual discussion to sector-specific applications. For example, manufacturing may emphasize compliance and safety records, IT services may prioritize credential verification and rapid onboarding, while healthcare may focus on data security and regulatory transparency. Contextualizing the framework in such industries will help bridge the gap between theoretical design and practical adoption. The future scope of blockchain technology in HRM is vast and multifaceted, offering opportunities to address current challenges while unlocking new possibilities for innovation and efficiency. By improving data privacy and scalability to enable global workforce management and sustainable practices, the blockchain technology has the potential to redefine HRM on multiple fronts. By continuing to explore these directions, researchers and practitioners can ensure that blockchain technology evolves into a transformative force for modern HR practices, ultimately contributing to organizational success and employee empowerment.

References

- Abou Jaoude, J., & George Saade, R. (2019). Blockchain applications - Usage in different domains. *IEEE Access*, 7(c), 45360–45381. <https://doi.org/10.1109/ACCESS.2019.2902501>
- Abram, M. D., Mancini, K. T., & Parker, R. D. (2020). Methods to Integrate Natural Language Processing Into Qualitative Research. *International Journal of Qualitative Methods*, 19, 1–6. <https://doi.org/10.1177/1609406920984608>
- Abu Ziden, A., & Chin Joo, O. (2020a). Exploring Digital Onboarding for Organisations: A Concept Paper. *International Journal Of Innovation, Creativity and Change* , 13(9), 734–750. www.ijicc.net
- Abu-Mahfouz, S., Halim, M. S. A., Bahkia, A. S., Alias, N., & Tambi, A. M. (2023). Sustainable human resource management practices in organizational performance: The mediating impacts of knowledge management and work engagement. *Journal of Entrepreneurship, Management and Innovation*, 19(2). <https://doi.org/10.7341/20231922>
- Adams, Z. (2022). A structural approach to labour law. *Cambridge Journal of Economics*, 46(3). <https://doi.org/10.1093/cje/beac008>
- Akdeniz, E. (2023). Toward a Sustainable Human Resources Management: Linking Green Human Resources Management Activities with ISO Standards. *SAGE Open*, 13(3). <https://doi.org/10.1177/21582440231192907>
- Al-Abbadi, L. H., & Abu Rumman, A. R. (2023). Sustainable performance based on entrepreneurship, innovation, and green HRM in e-Business Firms. *Cogent Business and Management*, 10(1). <https://doi.org/10.1080/23311975.2023.2189998>
- Albi, K. (2024). Innovative Strategies In Human Resource Management: Optimizing Organizational Performance In The Digital Age. *Journal Research of Social Science, Economics, and Management*, 3(10), 1933–1941. <https://doi.org/10.59141/jrssem.v3i10.659>
- Alsaadi, E. M. T. A., Khlebus, S. F., & Alabaichi, A. (2022). Identification of human resource analytics using machine learning algorithms. *Telkomnika (Telecommunication Computing Electronics and Control)*, 20(5), 1004–1015. <https://doi.org/10.12928/TELKOMNIKA.v20i5.21818>
- Anaam, E., Ghazal, T. M., Haw, S. C., Alzoubi, H. M., Alshurideh, M. T., & Mamun, A. Al. (2023). Utilization of Blockchain Technology in Human Resource Management. *2023 IEEE 2nd International Conference on AI in Cybersecurity, ICAIC 2023*, 1–5. <https://doi.org/10.1109/ICAIC57335.2023.10044181>

- Bansal, V. (2023). Automating HR Processes: Streamlining Employee Management. *International Journal for Research Publication and Seminars*, 14(4).
<https://doi.org/10.36676/jrps.2023-v14i4-007>
- Becker, K., & Bish, A. (2021). A framework for understanding the role of unlearning in onboarding. *Human Resource Management Review*, 31(1), 100730.
<https://doi.org/10.1016/j.hrmr.2019.100730>
- Belotti, M., Božić, N., Pujolle, G., & Secci, S. (2019). A Vademecum on Blockchain Technologies: When, Which, and How. *IEEE Communications Surveys and Tutorials*, 21(4), 3796–3838. <https://doi.org/10.1109/COMST.2019.2928178>
- Bentum, E. van. (2023). Employee Lifecycle Phase 1 – Onboarding. In *Kennzahlengestütztes HR-Risikomanagement*. <https://doi.org/10.37307/b.978-3-503-21114-2.04>
- Blatz, M. B. P. (2013). The benefits of. *Journal of Adhesive Dentistry*, 15(2), 103–104.
<https://doi.org/10.1201/1078/43192.17.3.20000601/31236.3>
- Blštáková, J., & Palenčárová, J. (2021). Human Resource Management in Healthcare. *SHS Web of Conferences*, 115. <https://doi.org/10.1051/shsconf/202111503003>
- Bodkhe, U., Tanwar, S., Parekh, K., Khanpara, P., Tyagi, S., Kumar, N., & Alazab, M. (2020). Blockchain for Industry 4.0: A comprehensive review. *IEEE Access*, 8, 79764–79800.
<https://doi.org/10.1109/ACCESS.2020.2988579>
- Bonache, J., & Festing, M. (2020). Research paradigms in international human resource management: An epistemological systematisation of the field. *German Journal of Human Resource Management*, 34(2). <https://doi.org/10.1177/2397002220909780>
- Boon, C., Jiang, K., & Eckardt, R. (2024). The Role of Time in Strategic Human Resource Management Research: A Review and Research Agenda. *Journal of Management*, 51(1), 172–211. <https://doi.org/10.1177/01492063241264250>
- Brewster, C. (2004). European perspectives on human resource management. *Human Resource Management Review*, 14(4), 365–382. <https://doi.org/10.1016/j.hrmr.2004.10.001>
- Byford, M., Watkins, M. D., & Triantogiannis, L. (2017). New Leaders Need More Than Onboarding. *Harvard Business Review*, 11(May-June), 1–17.
<https://hbr.org/2017/05/onboarding-isnt-enough>
- Cable, D. M., Gino, F., & Staats, B. R. (2013). Reinventing employee onboarding. *MIT Sloan Management Review*, 54(3), 23–28.
- Caldwell, C., & Peters, R. (2018). New employee onboarding – psychological contracts and ethical perspectives. *Journal of Management Development*, 37(1), 27–39.
<https://doi.org/10.1108/JMD-10-2016-0202>

- Capitano, J., Thomas, B. J., & Meglich, P. (2024). If I Knew Then What I Know Now: How Realistic Previews of Onboarding Influence Self-Selection and Expectations. *Group and Organization Management*, 49(3). <https://doi.org/10.1177/10596011221115609>
- Carpenter, M. J., & de Charon, L. C. (2014). Mitigating multigenerational conflict and attracting, motivating, and retaining millennial employees by changing the organizational culture: A theoretical model. *Journal of Psychological Issues in Organizational Culture*, 5(3), 68–84. <https://doi.org/10.1002/jpoc.21154>
- Carter, L., & Ubacht, J. (2018a). Panel: Blockchain applications in government. *ACM International Conference Proceeding Series*. <https://doi.org/10.1145/3209281.3209329>
- Carucci, R. (2018). To retain new hires, spend more time onboarding them. *Harvard Business Review*, 12, 1–5. https://hbr.org/2018/12/to-retain-new-hires-spend-more-time-onboarding-them?referral=03759&cm_vc=rr_item_page.bottom
- Caughlin, D. E., & Bauer, T. N. (2019). Data visualizations and human resource management: The state of science and practice. In *Research in Personnel and Human Resources Management* (Vol. 37). <https://doi.org/10.1108/S0742-730120190000037004>
- Chen, W., Xu, Z., Shi, S., Zhao, Y., & Zhao, J. (2018). A survey of blockchain applications in different domains. *ACM International Conference Proceeding Series*, 17–21. <https://doi.org/10.1145/3301403.3301407>
- Chillakuri, B. (2020). Understanding Generation Z expectations for effective onboarding. *Journal of Organizational Change Management*, 33(7), 1277–1296. <https://doi.org/10.1108/JOCM-02-2020-0058>
- Chillakuri, B., & Attili, V. S. P. (2022). Role of blockchain in HR's response to new-normal. *International Journal of Organizational Analysis*, 30(6), 1359–1378. <https://doi.org/10.1108/IJOA-08-2020-2363>
- Choudhary, V., Marchetti, A., Shrestha, Y. R., & Puranam, P. (2023). Human-AI Ensembles: When Can They Work? *Journal of Management*, 51(2), 536–569. <https://doi.org/10.1177/01492063231194968>
- Chung, C. H., & Chen, L. J. (2019). Text mining for human resources competencies: Taiwan example. *European Journal of Training and Development*, 45(6–7), 588–602. <https://doi.org/10.1108/EJTD-07-2018-0060>
- Claes, B., & Lakshman, C. (2012). Managing the Human Resources in the Supply Chain. *Supply Chain Forum: An International Journal*, 13(2). <https://doi.org/10.1080/16258312.2012.11517287>
- Dachner, A. M., & Makarius, E. E. (2021). Turn departing employees into loyal alumni. *Harvard Business Review*, 2021(March-April).

- Dai, H. N., Zheng, Z., & Zhang, Y. (2019). Blockchain for Internet of Things: A Survey. *IEEE Internet of Things Journal*, 6(5), 8076–8094. <https://doi.org/10.1109/JIOT.2019.2920987>
- Dalain, A. F. (2023). Nurturing Employee Engagement at Workplace and Organizational Innovation in Time of Crisis With Moderating Effect of Servant Leadership. *SAGE Open*, 13(2). <https://doi.org/10.1177/21582440231175150>
- Davidescu, A. A. M., Apostu, S. A., Paul, A., & Casuneanu, I. (2020). Work flexibility, job satisfaction, and job performance among romanian employees-Implications for sustainable human resource management. *Sustainability (Switzerland)*, 12(15). <https://doi.org/10.3390/su12156086>
- Di Francesco Maesa, D., & Mori, P. (2020). Blockchain 3.0 applications survey. *Journal of Parallel and Distributed Computing*, 138, 99–114. <https://doi.org/10.1016/j.jpdc.2019.12.019>
- Dong, Y., Zhang, H., & Li, L. (2021a). Mechanism construction of human resource management based on blockchain technology. *Journal of Systems Science and Information*, 9(3), 310–320. <https://doi.org/10.21078/JSSI-2021-310-11>
- Dosanjb, S. S. (1995). Sandia National Laboratories. *IEEE Computational Science and Engineering*, 2(2), 10–15. <https://doi.org/10.1109/99.388943>
- Ershov, V. V., & Ershova, E. A. (2021). Nature and classification of special principles of national labour law. *Vestnik Sankt-Peterburgskogo Universiteta. Pravo*, 12(1). <https://doi.org/10.21638/spbu14.2021.108>
- Esha, Z. T., Hafiz, N., & Islam, Md. A. (2023). Influence of Working from Home Culture on the Effectiveness of Virtual Onboarding of New Employees. *Society & Sustainability*, 5(1). <https://doi.org/10.38157/ss.v5i1.535>
- Fachrunnisa, O., & Hussain, F. K. (2020). Blockchain-based human resource management practices for mitigating skills and competencies gap in workforce. *International Journal of Engineering Business Management*, 12, 1–11. <https://doi.org/10.1177/1847979020966400>
- Foroglou, G., & Tsilidou, A. L. (2015). Further applications of the blockchain. *Conference: 12th Student Conference on Managerial Science and Technology, At Athens, MAY*, 0–8.
- Freire, C., & Pieta, P. (2022). The Impact of Green Human Resource Management on Organizational Citizenship Behaviors: The Mediating Role of Organizational Identification and Job Satisfaction. *Sustainability (Switzerland)*, 14(13). <https://doi.org/10.3390/su14137557>
- Gajendran, R. S., & Somaya, D. (2016). Employees Leave Good Bosses Nearly as Often as Bad Ones. *Harvard Business Review*, August, 2–5. <https://hbr.org/2016/03/employees-leave-good-bosses-nearly-as-often-as-bad-ones>

- Garengo, P., Sardi, A., & Nudurupati, S. S. (2022). Human resource management (HRM) in the performance measurement and management (PMM) domain: a bibliometric review. In *International Journal of Productivity and Performance Management* (Vol. 71, Issue 7). <https://doi.org/10.1108/IJPPM-04-2020-0177>
- George*, D. G., & Thomas, D. M. R. (2019). Integration of Artificial Intelligence in Human Resource. *International Journal of Innovative Technology and Exploring Engineering*, 9(2), 5069–5073. <https://doi.org/10.35940/ijitee.I3364.129219>
- Gill, S. S., Golec, M., Hu, J., Xu, M., Du, J., Wu, H., Walia, G. K., Murugesan, S. S., Ali, B., Kumar, M., Ye, K., Verma, P., Kumar, S., Cuadrado, F., & Uhlig, S. (2025). Edge AI: A Taxonomy, Systematic Review and Future Directions. In *Cluster Computing* (Vol. 28, Issue 1). Springer US. <https://doi.org/10.1007/s10586-024-04686-y>
- Godinho, T., Reis, I. P., Carvalho, R., & Martinho, F. (2023). Onboarding Handbook: An Indispensable Tool for Onboarding Processes. *Administrative Sciences*, 13(3). <https://doi.org/10.3390/admsci13030079>
- Gomathi Sankar, J. (2022). *Korea Review of International Studies Adoption of Blockchain Technology in Hrm*. July. <https://www.researchgate.net/publication/372497400>
- Gomes Rickardo, & Sousa Daniele. (2023). The Relevance of structured onboarding in the assimilation of organizational culture. *World Journal of Advanced Research and Reviews*, 18(1). <https://doi.org/10.30574/wjarr.2023.18.1.0659>
- Guest, D. E. (1997). Human resource management and performance: A review and research agenda. *International Journal of Human Resource Management*, 8(3), 263–276. <https://doi.org/10.1080/095851997341630>
- Guest, D. E. (2001). Human resource management: When research confronts theory. *International Journal of Human Resource Management*, 12(7), 1092–1106. <https://doi.org/10.1080/09585190110067837>
- Guest, D. E. (2011). Human resource management and performance: Still searching for some answers. *Human Resource Management Journal*, 21(1), 3–13. <https://doi.org/10.1111/j.1748-8583.2010.00164.x>
- Guo, Y., Cao, L., Gao, X., & Lv, X. (2019). Understanding of the common methods in e-HRM data security. *Journal of Physics: Conference Series*, 1237(2). <https://doi.org/10.1088/1742-6596/1237/2/022010>
- Haber, S., & Scott Stornetta, W. (1991). How to time-stamp a digital document. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 537 LNCS, 437–455. https://doi.org/10.1007/3-540-38424-3_32

- Hamouche, S. (2021). Human resource management and the COVID-19 crisis: Implications, challenges, opportunities, and future organizational directions. *Journal of Management and Organization*, 799–814. <https://doi.org/10.1017/jmo.2021.15>
- Hassan Onik, M. M., Miraz, M. H., & Kim, C. S. (2018a). A recruitment and human resource management technique using blockchain technology for industry 4.0. *IET Conference Publications*, 2018(CP747), 11–16. <https://doi.org/10.1049/cp.2018.1371>
- Hegadekatti, K. (2018). Blockchain and Human Resources Management. *SSRN Electronic Journal*, 1–9. <https://doi.org/10.2139/ssrn.3232203>
- Hendry, C., & Pettigrew, A. (1986). The Practice of Strategic Human Resource Management. *Personnel Review*, 15(5), 3–8. <https://doi.org/10.1108/eb055547>
- Hendry, C., & Pettigrew, A. (1990). Human resource management: An agenda for the 1990s. *The International Journal of Human Resource Management*, 1(1), 17–43. <https://doi.org/10.1080/095851990000000038>
- Huynh-The, T., Gadekallu, T. R., Wang, W., Yenduri, G., Ranaweera, P., Pham, Q. V., da Costa, D. B., & Liyanage, M. (2023). Blockchain for the metaverse: A Review. *Future Generation Computer Systems*, 143, 401–419. <https://doi.org/10.1016/j.future.2023.02.008>
- Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, 2017(January-February).
- Islam, M. T., & Tamzid, M. (2023). Artificial Intelligence in Human Resource Management. *Management Education for Achieving Sustainable Development Goals in the Context of Bangladesh*, 61–80. <https://doi.org/10.57240/dujmbk04>
- Jeske, D., & Olson, D. (2022). Onboarding new hires: recognising mutual learning opportunities. *Journal of Work-Applied Management*, 14(1). <https://doi.org/10.1108/JWAM-04-2021-0036>
- Kandpal, B. C., Sharma, D., Pandey, S., Gehlot, A., Sudhanshu, S., & Duggal, A. S. (2023). Automated Intervention of Blockchain in Human Resource Management. 2023 *International Conference on Disruptive Technologies (ICDT)*, 609–612. <https://doi.org/10.1109/icdt57929.2023.10150995>
- Khalid Alrashedi, A. (2024). The Key Sustainable Strategies Criteria for Effective Human Resource Management Practices. *Sustainability*, 16(12), 5250. <https://doi.org/10.3390/su16125250>
- Khandelwal, P., Johari, R., Gaur, V., & Vashisth, D. (2021). BlockChain Technology based Smart Contract Agreement on REMIX IDE. *Proceedings of the 8th International Conference on Signal Processing and Integrated Networks, SPIN 2021*. <https://doi.org/10.1109/SPIN52536.2021.9565983>

- Klotz, A. C., Swider, B. W., Shao, Y., & Prengler, M. K. (2021). The paths from insider to outsider: A review of employee exit transitions. *Human Resource Management*, 60(1), 119–144. <https://doi.org/10.1002/hrm.22033>
- Koncheva, V. A., Odintsov, S. V., & Khmel'nitski, L. (2019). *Blockchain in HR*. 105(Iscde), 787–790. <https://doi.org/10.2991/iscde-19.2019.154>
- König, C. J., Richter, M., & Isak, I. (2022). Exit interviews as a tool to reduce parting employees' complaints about their former employer and to ensure residual commitment. *Management Research Review*, 45(3). <https://doi.org/10.1108/MRR-02-2021-0148>
- Kroon, B., & Paauwe, J. (2022). HRM in 21st century small organizations: a midrange typology to describe, contrast and contextualize the phenomenon. *International Journal of Human Resource Management*, 33(16). <https://doi.org/10.1080/09585192.2021.1915359>
- Krugielka, A., Bartkowiak, G., Knap-Stefaniuk, A., Sowa-Behtane, E., & Dachowski, R. (2023). Onboarding in Polish Enterprises in the Perspective of HR Specialists. *International Journal of Environmental Research and Public Health*, 20(2). <https://doi.org/10.3390/ijerph20021512>
- Labrosse, M. (2008). *Project Management The Traction of Success*. 83–88. <https://doi.org/10.1002/ert>
- Lalwani, P. (2023). *What Is Employee Onboarding Process? Definition, Templates, and Best Practices*. <https://www.spiceworks.com/hr/recruitment-onboarding/articles/what-is-new-employee-onboarding/>.
- Lauring, J., & Jonasson, C. (2024). What is hybrid work? Towards greater conceptual clarity of a common term and understanding its consequences. *Human Resource Management Review*, 35(1), 101044. <https://doi.org/10.1016/j.hrmr.2024.101044>
- Lee, J., & Varon, A. L. (2020). Employee Exit, Voice, Loyalty, and Neglect in Response to Dissatisfying Organizational Situations: It Depends on Supervisory Relationship Quality. *International Journal of Business Communication*, 57(1), 30–51. <https://doi.org/10.1177/2329488416675839>
- Lepak, D. P., Liao, H., Chung, Y., & Harden, E. E. (2006). A Conceptual Review of Human Resource Management Systems in Strategic Human Resource Management Research. *Research in Personnel and Human Resources Management*, 25(06), 217–271. [https://doi.org/10.1016/S0742-7301\(06\)25006-0](https://doi.org/10.1016/S0742-7301(06)25006-0)
- M, M., & R, V. (2017). The Case of Onboarding Process at Company X. *Ushus - Journal of Business Management*, 16(3). <https://doi.org/10.12725/ujbm.40.5>

- M. Mallick, A. Sengupta, S. Ingawale, & A. Aljapurkar. (2022a). Using blockchain technology for recruitment effectiveness in industry 4.0. *Prayukti – Journal of Management Applications*, 02(01), 52–57. <https://doi.org/10.52814/pjma.2022.2107>
- Macke, J., & Genari, D. (2019). Systematic literature review on sustainable human resource management. *Journal of Cleaner Production*, 208. <https://doi.org/10.1016/j.jclepro.2018.10.091>
- Madhani, P. M. (2022). *Blockchain Applications in HR : Key Advantages*. 18(1), 1–9.
- Mahapatra, D. (2020). A Study of Blockchain Solutions for IoT Issues. *International Journal for Research in Applied Science and Engineering Technology*, 8(5), 986–990. <https://doi.org/10.22214/ijraset.2020.5156>
- Maksymiuk, H. (2017). Onboarding New Employees: Review of Current Practicies. *Scientific Journal of Polonia University*, 20(1), 123–128. <https://doi.org/10.23856/2014>
- Malik, A., Budhwar, P., & Kazmi, B. A. (2023). Artificial intelligence (AI)-assisted HRM: Towards an extended strategic framework. In *Human Resource Management Review* (Vol. 33, Issue 1). <https://doi.org/10.1016/j.hrmr.2022.100940>
- Malini, T., & Srinivas, D. B. (2020). Technological transcends: Impact of industrial 4.0 on human resource functions. *Proceedings of the 4th International Conference on IoT in Social, Mobile, Analytics and Cloud, ISMAC 2020*, 816–820. <https://doi.org/10.1109/I-SMAC49090.2020.9243338>
- Maurer, R. (2018). New employee onboarding process: Proper onboarding is key to retaining, engaging talent. *SHRM Website*, 1–2.
- McGovern, P., Gratton, L., Hope-Hailey, V., Stiles, P., & Truss, C. (1997). Human resource management on the line? *Human Resource Management Journal*, 7(4), 12–29. <https://doi.org/10.1111/j.1748-8583.1997.tb00286.x>
- Mefi, N. P., & Asoba, S. N. (2020). Sustainable Human Resource Practices For Organizational Competitiveness Post The Covid-19 Pandemic. *Academy of Entrepreneurship Journal*, 27(2).
- Michailidis, M. P. (2018). The challenges of AI and blockchain on HR recruiting practices. *Cyprus Review*, 30(2), 169–180.
- Mishra, H., & Venkatesan, M. (2021). Blockchain in human resource management of organizations: an empirical assessment to gauge HR and non-HR perspective. *Journal of Organizational Change Management*, 34(2). <https://doi.org/10.1108/JOCM-08-2020-0261>
- Mishra, M., & Joshi, P. (2020). Application & challenges of blockchain in hrm: the diffusion of innovation theory perspective. *Shodh Sarita*, 7(25).

- Molina-Azorin, J. F., López-Gamero, M. D., Tarí, J. J., Pereira-Moliner, J., & Pertusa-Ortega, E. M. (2021). Environmental management, human resource management and green human resource management: A literature review. In *Administrative Sciences* (Vol. 11, Issue 2). <https://doi.org/10.3390/ADMSCI11020048>
- Moon, H. (2018). Unleashing apprenticeship: from onboarding to professional development. *European Journal of Training and Development*, 42(1–2). <https://doi.org/10.1108/EJTD-06-2017-0056>
- Mployment, During One of the Employee 'S Last Working*. (2018). 8(1), 464–473.
- Nagarathinam, A. N. (2018). *Potential impact of blockchain on HR and people management Human Resource Management View project Blockchain View project*. August. www.jetir.org
- Nayak, P., & Park, P. (n.d.). *Final Question Breslin*.
- Nayak, P., & Park, P. (2020). What are the Best Practices for Offboarding Trends in Global Companies? *Cornell University Library*, 1–4. <https://www.ecommons.cornell.edu/handle/1813/102851>
- Neiheiser, R., Inácio, G., Rech, L., & Fraga, J. (2020). HRM smart contracts on the blockchain: emulated vs native. *Cluster Computing*, 23(3), 2105–2122. <https://doi.org/10.1007/s10586-020-03063-9>
- Norton, G. (2014). Onboarding not Working? Learn from your Offboarding Practices. *Workforce Solutions Review*, 5(5).
- Nurimansjah, R. A. (2023). Dynamics of Human Resource Management: Integrating Technology, Sustainability, and Adaptability in the Modern Organizational Landscape. *Golden Ratio of Mapping Idea and Literature Format*, 3(2). <https://doi.org/10.52970/grmilf.v3i2.324>
- Olivas-Lujan, M. R. (2019). Blockchains 2019 in e-HRM: Hit or Hype? *Advanced Series in Management*, 23, 117–139. <https://doi.org/10.1108/S1877-636120190000023010>
- Pal, A., Tiwari, C. K., & Haldar, N. (2021). Blockchain for business management: Applications, challenges and potentials. *Journal of High Technology Management Research*, 32(2), 100414. <https://doi.org/10.1016/j.hitech.2021.100414>
- Palmquist, A. (2023). Design Elements of Conflict: A Design Study of a Gamified Smartphone Application for Employee Onboarding. *Technology, Knowledge and Learning*, 28(3). <https://doi.org/10.1007/s10758-023-09657-7>
- Paulus, P. (2023). Effective Onboarding and Socialization Tactics: A Communication Psychology Approach to Human Resource Management. *Golden Ratio of Mapping Idea and Literature Format*, 3(1). <https://doi.org/10.52970/grmilf.v3i1.353>

- Peacock, R., & Ruppel, M. (2019). Holistic Onboarding of a Generation Y Team Member. *Onboarding 2.0: Methods of Designing and Deploying Effective Onboarding Training for Academic Libraries*, 0–12.
https://scholarworks.boisestate.edu/lib_facpubs/142%0Ahttps://scholarworks.boisestate.edu/cgi/viewcontent.cgi?article=1144&context=lib_facpubs
- Petrilli, S., Galuppo, L., & Ripamonti, S. C. (2022). Digital Onboarding: Facilitators and Barriers to Improve Worker Experience. *Sustainability (Switzerland)*, 14(9).
<https://doi.org/10.3390/su14095684>
- Prathna Kisha, D., & Balu, L. (2018). The Influence of Human Resource Onboarding on an Employee ' s Intention to Stay i n Rockwell Automation Pvt. Ltd. *International Journal of Engineering Technology Science and Research*, 5(3).
- Prikshat, V., Islam, M., Patel, P., Malik, A., Budhwar, P., & Gupta, S. (2023). AI-Augmented HRM: Literature review and a proposed multilevel framework for future research. *Technological Forecasting and Social Change*, 193.
<https://doi.org/10.1016/j.techfore.2023.122645>
- Racolța-Paina, N. D., & Irini, R. D. (2021). Generation z in the workplace through the lenses of human resource professionals – a qualitative study. *Quality - Access to Success*, 22(183), 78–85.
- Richman, N. (2015). Human Resource Management and Human Resource Development: Evolution and Contributions. *Creighton Journal of Interdisciplinary Leadership*, 1(2).
<https://doi.org/10.17062/cjil.v1i2.19>
- Ritz, E., Donisi, F., Elshan, E., & Rietsche, R. (2023). Artificial Socialization? How Artificial Intelligence Applications Can Shape A New Era of Employee Onboarding Practices. *Proceedings of the Annual Hawaii International Conference on System Sciences, 2023-Janua*, 155–164.
- Ross, W. E., Huang, K. H. C., & Jones, G. H. (2014). Executive onboarding: Ensuring the success of the newly hired department chair. *Academic Medicine*, 89(5), 728–733.
<https://doi.org/10.1097/ACM.0000000000000214>
- Sahni, U., Garg, S., Srivastava, T., Sharma, T., Malsa, N., Ghosh, A., Shaw, R. N., & Gupta, V. (2023). Framework for Land Registry System Using Ethereum Blockchain. *Communications in Computer and Information Science*, 1749 CCIS.
https://doi.org/10.1007/978-3-031-25088-0_39
- Saks, A. M. (2022). Caring human resources management and employee engagement. *Human Resource Management Review*, 32(3), 100835. <https://doi.org/10.1016/j.hrmr.2021.100835>

- Salah, D., Ahmed, M. H., & Eldahshan, K. (2020a). Blockchain Applications in Human Resources Management: Opportunities and Challenges. *ACM International Conference Proceeding Series*, 383–389. <https://doi.org/10.1145/3383219.3383274>
- Salah, D., Ahmed, M. H., & Eldahshan, K. (2020b). Blockchain Applications in Human Resources Management: Opportunities and Challenges. *ACM International Conference Proceeding Series*, 383–389. <https://doi.org/10.1145/3383219.3383274>
- Sani, K. F., Adisa, T. A., Adekoya, O. D., & Oruh, E. S. (2023). Digital onboarding and employee outcomes: empirical evidence from the UK. *Management Decision*, 61(3). <https://doi.org/10.1108/MD-11-2021-1528>
- Saura, J. R., Palos-Sanchez, P., & Grilo, A. (2019). Detecting indicators for startup business success: Sentiment analysis using text data mining. *Sustainability (Switzerland)*, 11(3), 1–14. <https://doi.org/10.3390/su11030917>
- Schuler, R. S., Budhwar, P. S., & Florkowski, G. W. (2002). International human resource management: Review and critique. *International Journal of Management Reviews*, 4(1), 41–70. <https://doi.org/10.1111/1468-2370.00076>
- Sharif, M. M., & Ghodoosi, F. (2022). The Ethics of Blockchain in Organizations. *Journal of Business Ethics*, 178(4), 1009–1025. <https://doi.org/10.1007/s10551-022-05058-5>
- Shufitinsky, A., & Cox, R. (2019). Losing talent on day one: Onboarding millennial employees in health care organizations. *Organization Development Journal*, 37(4), 33–51.
- Sirois, S. (2021). *A guide to employee volunteering*. <https://quickbooks.intuit.com/r/manage-employees/employee-productivity/>
- Sithambaram, R. A., & Tajudeen, F. P. (2023). Impact of artificial intelligence in human resource management: a qualitative study in the Malaysian context. *Asia Pacific Journal of Human Resources*, 61(4). <https://doi.org/10.1111/1744-7941.12356>
- Sivathanu, B., & Pillai, R. (2018). Smart HR 4.0 – how industry 4.0 is disrupting HR. *Human Resource Management International Digest*, 26(4), 7–11. <https://doi.org/10.1108/HRMID-04-2018-0059>
- Snell, A. (2006). onboarding best practice Using research to connect onboarding. *Strategic HR Review*, 5(6), 32–35.
- Soze, K. (2017). *Blockchain- Novoive to Expert*.
- Squarepants, S. (2022). Bitcoin: A Peer-to-Peer Electronic Cash System. *SSRN Electronic Journal*, 1–9. <https://doi.org/10.2139/ssrn.3977007>
- Stahl, G. K., Brewster, C. J., Collings, D. G., & Hajro, A. (2020). Enhancing the role of human resource management in corporate sustainability and social responsibility: A multi-

- stakeholder, multidimensional approach to HRM. *Human Resource Management Review*, 30(3). <https://doi.org/10.1016/j.hrmr.2019.100708>
- Stein, M. A., & Christiansen, Lilith. (2010). Successful Onboarding: A Strategy to Unlock Hidden Potential Within Your Organization. *Kaiser Associates, USA*(1), 51–87.
- Stone, D. L., & Deadrick, D. L. (2015a). Challenges and opportunities affecting the future of human resource management. *Human Resource Management Review*, 25(2), 139–145. <https://doi.org/10.1016/j.hrmr.2015.01.003>
- Stone, D. L., & Deadrick, D. L. (2015b). Challenges and opportunities affecting the future of human resource management. *Human Resource Management Review*, 25(2), 139–145. <https://doi.org/10.1016/j.hrmr.2015.01.003>
- Stone, D. L., Deadrick, D. L., Lukaszewski, K. M., & Johnson, R. (2015). The influence of technology on the future of human resource management. *Human Resource Management Review*, 25(2), 216–231. <https://doi.org/10.1016/j.hrmr.2015.01.002>
- Sturt, D. (2019). Your Company Needs a Process for Offboarding Employees Gracefully. *Harvard Business Review*.
- Sukalova, V., Stofkova, Z., & Stofkova, J. (2022). Human Resource Management in Sustainable Development. *Sustainability (Switzerland)*, 14(21). <https://doi.org/10.3390/su142114258>
- Sulich, A., & Zema, T. (2020). Role of the Management in the World Driven by the Industry 4.0. *Education Excellence and Innovation Management: A 2025 Vision to Sustain Economic Development during Global Challenges*, 2565–2576.
- Tasatanattakool, P. (2018a). *Blockchain : Challenges and Applications*. 473–475.
- Tasatanattakool, P. (2018b). *Blockchain : Challenges and Applications*. 473–475.
- Than, S. T., Le, P. B., Le, T. P., & Nguyen, D. T. N. (2023). Stimulating product and process innovation through HRM practices: the mediating effect of knowledge management capability. *Evidence-Based HRM*, 11(1). <https://doi.org/10.1108/EBHRM-04-2021-0068>
- Tung, R. L. (2016). New perspectives on human resource management in a global context. *Journal of World Business*, 51(1), 142–152. <https://doi.org/10.1016/j.jwb.2015.10.004>
- Tyskbo, D. (2019). Managers' views on how intellectual capital is recognized and managed in practice: A multiple case study of four Swedish firms. *Journal of Intellectual Capital*, 20(2), 282–304. <https://doi.org/10.1108/JIC-01-2018-0017>
- Ulatowska, R., Wainio, E., & Pierzchała, M. (2023). Digital transformation in HRM of the modern business service sector in Finland and Poland. *Journal of Organizational Change Management*, 36(7). <https://doi.org/10.1108/JOCM-11-2022-0339>

- Wagner, C. G. (2009). Getting practical about the future. *Futurist*, 43(2), 3.
- Walker-Schmidt, W., Kaul, C., & Crocker Papadakis, L. (2022). Onboarding Effects on Engagement and Retention in the IT Sector. *Impacting Education: Journal on Transforming Professional Practice*, 7(4). <https://doi.org/10.5195/ie.2022.220>
- Wang, E. Z., Lee, C. C., & Li, Y. (2022). Assessing the impact of industrial robots on manufacturing energy intensity in 38 countries. *Energy Economics*, 105. <https://doi.org/10.1016/j.eneco.2021.105748>
- Wang, T. (2023). *Retraction Retracted: A Study on the Innovative Use of Blockchain in the Human Resources Service Industry*. 2022.
- Wang, X., Feng, L., Zhang, H., Lyu, C., Wang, L., & You, Y. (2017). Human Resource Information Management Model based on Blockchain Technology. *Proceedings - 11th IEEE International Symposium on Service-Oriented System Engineering, SOSE 2017*, 168–173. <https://doi.org/10.1109/SOSE.2017.34>
- Wei, P. C., Wang, D., Zhao, Y., Tyagi, S. K. S., & Kumar, N. (2020). Blockchain data-based cloud data integrity protection mechanism. *Future Generation Computer Systems*, 102, 902–911. <https://doi.org/10.1016/j.future.2019.09.028>
- Wood, S. (1999). Human resource management and performance. *International Journal of Management Reviews*, 1(4), 367–413. <https://doi.org/10.1111/1468-2370.00020>
- Yi, C. S. S., Yung, E., Fong, C., & Tripathi, S. (2020). Benefits and Use of Blockchain Technology to Human Resources Management: A Critical Review. *International Journal of Human Resource Studies*, 10(2), 131. <https://doi.org/10.5296/ijhrs.v10i2.16932>
- Zamcu, E. G. (2014). Trends and Challenges in the modern HRM - Talent Management. *SEA-Practical Application of Science*, 2(4).
- Zavyalova, E., Sokolov, D., Kucherov, D., & Lisovskaya, A. (2022). The Digitalization of Human Resource Management: Present and Future. *Foresight and STI Governance*, 16(2). <https://doi.org/10.17323/2500-2597.2022.2.42.51>
- Zhang, C., Wu, C., & Wang, X. (2020). Overview of blockchain consensus mechanism. *ACM International Conference Proceeding Series*, 7–12. <https://doi.org/10.1145/3404512.3404522>
- Zhang, J., & Chen, Z. (2024). Exploring Human Resource Management Digital Transformation in the Digital Age. *Journal of the Knowledge Economy*, 15(1). <https://doi.org/10.1007/s13132-023-01214-y>
- Zheng, Z., Xie, S., Dai, H.-N., Chen, X., & Wang, H. (2017). Blockchain Challenges and Opportunities : A Survey Shaoan Xie Hong-Ning Dai Huaimin Wang. *International Journal*

of Web and Grid Services, 14(4), 1–24.

<http://inpluslab.sysu.edu.cn/files/blockchain/blockchain.pdf>

Zhou, L., Liu, Y., Xue, T., & Zhang, X. (2023). Innovation-oriented HRM, TMT reflexivity and organizational change in China: the moderated mediation effect of CEO leader mindfulness. *Asia Pacific Business Review*, 29(1). <https://doi.org/10.1080/13602381.2022.2139058>

Appendix 1

Questionnaire

Q1. Demographic Details

Name	
Gender	
Age	
Qualification	
Designation	
Department/ Function	
Relevant Experience (In years)	
Name of Organization	
Place/ City	
Contact No.	
Email ID	

Q2. Provide an overview of your role within the HR department of your organization.

Q3. Can you describe the current onboarding and offboarding process adopted in your company?

Q4. How efficient are the onboarding and offboarding processes in your organization?

Q5. What are the key challenges you face in managing the onboarding and offboarding of employees within your organization?

Q6. How does the automobile manufacturing industry influence the onboarding and offboarding of employees?

Q7. In your opinion, what improvements or enhancements could be made to streamline the onboarding and offboarding processes within your organisation?

Q8. How open are you to adopt new technology to address the challenges of HR? Kindly cite some examples that depict the adoption of new technology in HRM.

Q9. How would you categorize your current organization in terms of familiarity with blockchain technology?

- a. Novice
- b. Competence
- c. Expert

Q10. Could you explore any blockchain-based solutions in other aspects of your automobile manufacturing operations? Please cite some examples or case studies.

Q11. Please share your vision regarding how blockchain technology could be applied to improve your organization's onboarding and offboarding processes.

Q12. What specific benefits do you think blockchain could offer to enhance transparency and security in HR operations? What do you think would be the key success factors for adopting blockchain technology in HR processes?

Q13. What potential obstacles or concerns do you foresee in integrating blockchain technology into HR processes within your industry?

Q14. Are there any regulatory or compliance considerations specific to the automotive sector that need to be addressed when implementing blockchain solutions?

Q15. How do you envision the implementation process of a blockchain-based HR management system within your organization?

Q16. How do you think employees within your organization would respond to the introduction of blockchain-based HR systems?

Q17. Is there anything else you would like to add before we conclude the interview?

a. No

b. Yes, -----

Appendix 2

Interview Transcript

Name: Meenu Gakhar

Gender: Female

Age: 41

Qualification: Masters

Designation: Senior HR Manager

Work Experience in Years: 15

Name of the Organization: ROCKMAN INDUSTRIES LIMITED

City: Ludhiana

Contact Number: 91-1143270701

Email ID: bindu@rockmanindustries.com

Interview Details:

Interviewer: What is your role within the HR department?

Interviewee: I am the Senior HR Manager at the company, overseeing talent acquisition, employee engagement, and performance management. I also supervise the onboarding and offboarding processes.

Interviewer: How does your company handle onboarding and offboarding of employees?

Interviewee: We follow a structured onboarding process that includes orientation, training, and mentoring for new employees. For offboarding, we conduct exit interviews and ensure all administrative tasks like paperwork and final settlements are completed.

Interviewer: How would you rate the efficiency of these processes?

Interviewee: I would rate the efficiency as moderate. Onboarding is fairly smooth, but offboarding can sometimes be delayed due to administrative bottlenecks.

Interviewer: What challenges do you face in managing onboarding and offboarding?

Interviewee: One of the main challenges is managing the volume of paperwork, especially during offboarding. Additionally, ensuring that every department (IT, finance, etc.) completes their tasks on time can be difficult.

Interviewer: How does the automobile manufacturing industry impact these processes?

Interviewee: The industry is highly dynamic, with periods of rapid hiring and layoffs due to market demand. This fluctuation adds pressure on our HR team to manage the onboarding and offboarding efficiently.

Interviewer: What improvements could be made to streamline onboarding and offboarding?

Interviewee: We could definitely benefit from digitizing more of the paperwork and automating certain approval workflows. More consistent communication between departments would also help.

Interviewer: How open is your organization to adopting new HR technology?

Interviewee: We are fairly open to adopting new technology, especially if it improves operational efficiency. However, budget constraints and management approval can slow down the adoption process.

Interviewer: How familiar is your organization with blockchain technology?

Interviewee: a. Novice

We are still in the early stages of learning about blockchain. Most of the team is unfamiliar with its applications in HR.

Interviewer: Are there any blockchain solutions being used or considered in other areas of your business?

Interviewee: Not at the moment, but we have heard of blockchain being used in supply chain management in the automotive sector. It hasn't reached our HR department yet.

Interviewer: Do you think blockchain can improve the onboarding and offboarding process?

Interviewee: Yes, I think it could help by creating a transparent and secure system for tracking employee records, contracts, and certifications. It would also be useful for ensuring compliance during offboarding.

Interviewer: What challenges might arise in integrating blockchain into HR?

Interviewee: The biggest challenge would likely be the cost of implementation and training the HR team to use the system effectively. There may also be resistance from employees who are unfamiliar with blockchain.

Interviewer: Are there any regulatory or compliance concerns specific to the automotive industry for implementing blockchain?

Interviewee: There could be concerns related to data privacy, especially when dealing with sensitive employee information. We would need to ensure compliance with labor laws and data protection regulations.

Interviewer: How do you think employees would react to blockchain-based HR systems?

Interviewee: Some employees, especially those who are more tech-savvy, might appreciate the transparency and security features. However, others might be skeptical or concerned about privacy issues.

Interviewer: If a blockchain-based HR system were to be implemented in your organization, how would you prefer the implementation process to be carried out?

Interviewee: I would prefer a phased implementation with pilot testing in one department before rolling it out company-wide. Training and support for HR staff would be essential, as well as clear communication to employees about how the system works.

Interviewer: Would you like to share any incident related to HR onboarding or offboarding process?

Interviewee: There was one instance where a new employee's paperwork was delayed due to a communication gap between HR and the IT department. As a result, they didn't have access to the necessary systems for the first week, which affected their productivity.

Appendix 3

HR-Focused Validation Questionnaire

Please rate each statement below based on your experience with the onboarding and offboarding frameworks, from the perspective of HR operations, and employee experience.

Name: _____

Designation: _____

Department: _____

Date of Evaluation: _____

1. On a scale of 1 to 5, how clear and comprehensive do you find the proposed framework for blockchain-based HR onboarding and offboarding processes?

- ☐ 1-Not clear/comprehensive at all
- ☐ 2-Slightly clear/comprehensive
- ☐ 3-Moderately clear/comprehensive
- ☐ 4-Mostly clear/comprehensive
- ☐ 5-Very clear/comprehensive

2. How suitable do you think the proposed architecture is for integrating blockchain into HR systems for onboarding and offboarding?

- ☐ 1-Not at all suitable
- ☐ 2-Slightly suitable
- ☐ 3-Moderately suitable
- ☐ 4-Mostly suitable
- ☐ 5-Very suitable

3. To what extent do you believe the proposed framework addresses current challenges in traditional HR onboarding and offboarding processes?

- ☐ 1-Does not address at all
- ☐ 2-Addresses to a small extent
- ☐ 3-Addresses to some extent
- ☐ 4-Addresses to a large extent
- ☐ 5-Completely addresses

4. How confident are you that the proposed architecture can effectively enhance data security and privacy in HR onboarding and offboarding processes?

- ☐ 1-Not at all confident
- ☐ 2-Slightly confident
- ☐ 3-Moderately confident
- ☐ 4-Mostly confident
- ☐ 5-Very confident

5. Do you think the proposed framework sufficiently leverages blockchain technology's capabilities to improve transparency and accountability in HR onboarding and offboarding?

- ☐ 1-Not at all
- ☐ 2-Slightly
- ☐ 3-Moderately
- ☐ 4-Significantly
- ☐ 5-Very significantly

6. On a scale of 1 to 5, how feasible do you find the implementation of the proposed framework in real-world HR environments?

- ☐ 1-Not feasible at all
- ☐ 2-Slightly feasible

- ☐ 3-Moderately feasible
- ☐ 4-Mostly feasible
- ☐ 5-Highly feasible

7. How likely do you think organizations are to adopt the proposed framework for blockchain-based HR onboarding and offboarding in the near future?

- ☐ 1-Very unlikely
- ☐ 2-Unlikely
- ☐ 3-Neutral
- ☐ 4-Likely
- ☐ 5-Very likely

8. In your opinion, what are the key strengths of the proposed framework and architecture for blockchain-based HR onboarding and offboarding? (Select all that apply)

- ☐ Improved data security
- ☐ Enhanced transparency
- ☐ Simplified verification processes
- ☐ Other (please specify)
- ☐ None/not sure

9. What do you perceive as the main challenges or limitations of the proposed framework and architecture? (Select all that apply)

- ☐ Integration complexity
- ☐ Regulatory concerns
- ☐ Cost implications
- ☐ Other (please specify)

☐ None/not sure

10. Do you agree that the proposed framework adequately addresses the needs and challenges of HR onboarding and offboarding processes in the context of blockchain technology?

☐ Yes

☐ No

☐ Not sure

Any Comments:

Expert Signature:

Blockchain Technology Focused Validation Questionnaire

Please rate each statement below from a technical perspective, focusing on data management, system integration and security.

Name: _____

Designation: _____

Department: _____

Date of Evaluation: _____

1. Does the theoretical integration of the blockchain-based HR onboarding and offboarding system with existing IT infrastructure appear seamless?

☐ Yes

☐ No

2. Based on theoretical considerations, are there any potential compatibility concerns between the proposed system and other IT systems within the organization?

☐ Yes

☐ No

3. How well does the conceptual framework suggest the system would manage and scale to accommodate increases in theoretical data volume during peak periods?

☐ 1-Ineffectively

☐ 2-Moderately effectively

☐ 3-Very-effectively

4. Based on the conceptual framework, are there potential theoretical performance bottlenecks or latency issues anticipated during system operations?

☐ Yes

☐ No

5. How robust does the conceptual framework describe the system's security measures (access controls)?

☐ 1-Not robust

☐ 2-Moderately robust

☐ 3-Very robust

6. Based on the conceptual framework, are there any theoretical incidents of data loss or corruption anticipated since the system's theoretical implementation?

☐ Yes

☐ No

Any Comments:

Expert Signature:

List of Publications

Research Papers

1. P. Chanda *et al.*, “Enhancing Employee Onboarding through Blockchain-Based Identity Verification in HR Management,” *International Journal of Information Engineering and Electronic Business*, MECS Press, vol. 6, pp. 29-41, doi: 10.5815/ijieeb.2024.06.03.
2. P. Chanda, *et al.*, “Human Resource Managers' Perceptions Towards the Implementation of Blockchain Technology in the Automobile Industry: A Qualitative Study,” *International Journal of Information Engineering and Electronic Business*, MECS Press (Accepted-In Production)
3. P. Chanda, *et al.*, “Blockchain-Driven Human Resource Management Innovations for Sustainable Tourism: A Multi-Dimensional Exploration,” *International Journal of Information Engineering and Electronic Business*, MECS Press (Accepted-In Production)

Conference Proceedings

1. P. Chanda and P. Singh, “Mapping the Landscape of Blockchain Research in Human Resource Management: A Bibliometric Analysis,” in *Proceedings of the 2023 Fifteenth International Conference on Contemporary Computing (IC3-2023)*. Association for Computing Machinery, pp. 115–126, doi: <https://doi.org/10.1145/3607947.3607968>.
2. P. Chanda et al., “PBFT Consensus Mechanism for Human Resource Offboarding Procedures Based on Blockchain Technology,” *International Conference on Trends in Computational and Cognitive Engineering, Lecture Notes in Networks and Systems*, Springer, vol. 961, 2023, doi: https://doi.org/10.1007/978-981-97-1923-5_32.

Book Chapter

1. P. Chanda et al., “Developing secure framework using blockchain technology for E-healthcare”, Artificial Intelligence, Blockchain, Computing and Security Volume 1, *CRC Press*, 2023.

List of Conferences

1. P. Chanda and P. Singh, “Exploring the Role of Blockchain-based Identity Verification in Streamlining and Securing the Employee Onboarding Process in HR Management,” in *International Conference on Innovation in Engineering & Management: Sustainability Through Creativity & Innovation (ICIEM’23)*, Birla Institute of Technology, Mesra (Ranchi), Noida
2. P. Chanda and P. Singh, “Utilizing Blockchain Technology: Untangle the offboarding process of Human Resource,” in *Exploring the Glorious Past, Promising Present and Future Roadmap to Vishwa Guru India*, GHG Khalsa College of Education, Ludhiana, 21-22 April 2023.
3. P. Chanda and P. Singh, “Mapping the Landscape of Blockchain Research in Human Resource Management: A Bibliometric Analysis,” in *15th International Conference on Contemporary Computing (IC3- 2023)*, Jaypee Institute of Information Technology (JIIT, Noida), 3-5 August 2023.
4. P. Chanda and P. Singh, “Exploratory review of Blockchain-based technology in the application domain of Human Resource Management,” in *International Conference on Business in a Turbulent World: Keeping Connection Alive*, Mittal School of Business, Lovely Professional University, Phagwara, 21 November 2022.
5. P. Chanda et al., “PBFT Consensus Mechanism for Human Resource Offboarding Procedures Based on Blockchain Technology,” *5th International Conference on Trends in Computational and Cognitive Engineering (TCCE-2023)*, Pranveer Singh Institute of Technology, Kanpur, 24-25 November, 2023

List of Intellectual Property

1. Applicant: Lovely Professional University; Inventor: Priya Chanda, Pritpal Singh, and Sukanta Ghosh; Title: “Blockchain-Based Secure Identity Verification”, Indian Patent, Application No. 202311079297 (Status: Published)
2. Applicant: Lovely Professional University; Inventor: Priya Chanda, Pritpal Singh, and Sukanta Ghosh; Title: “Blockchain-Driven Performance Evaluation and Feedback System for New Hires”; Indian Patent, Application No. 202311075339 (Status: Published)

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1. A research data collection tool for designing a framework for human resource on-boarding and off-boarding practices using blockchain technology (Accepted for Publication)