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Categorization of Blockchain Technology Applications in Human Resource Management: An Interpretive Structural Modeling Approach

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Abstract: **-** Human resource stores large amounts of employee data, vulnerable to sabotage and theft. Blockchain cybersecurity programs restrict access to authorized information, reducing internal violations. This research used a comparative approach with exploratory and qualitative methods. Library and field methods, including interviews and questionnaires, were used for theoretical and model development. The qualitative part involved family experts and psychologists, while the quantitative part involved families in Kermanshah province in Iran. Qualitative sampling used purposive approach, while random sampling was done for the quantitative part. Thematic analysis and fuzzy Delphi were used for data analysis. Interpretive structural modeling and MICMAC software were used for factor categorization. Eight factors were categorized across three levels of applications. Level 1 includes three applications: "management of fake job certificates," "certificate issuing system and training scores," and "employer branding improvement." Level 2 includes "recruitment and talent management" and "data security management," while Level 3 includes "salary information processing," "solving information asymmetry and reducing risk," and "reducing the skills gap in the workforce. Blockchain in HRM promotes participation from employees and managers, updating information and analyzing skills and employment experiences.

Keywords*: Human Resource Management, Blockchain Technology, Interpretive Structural Modeling.*

1. Introduction

Blockchain is a decentralized database technology that enables tamper-proof transactions, addressing issues related to trust, decentralization, and transparency among individuals, organizations, and institutions (Kim et al., 2020; Bai et al., 2024; Moezzi et al., 2012). Although blockchain research initially focused on digital currencies, it has revealed a wider range of potentials, such as supply chain management, certification and smart city projects, and resource management in organizations (Daneshmandi et al., 2023; Dehkordy et la., 2013; Shamsaddini et al., 2015). Blockchain technology aligns with sustainable development initiatives, including enhancing supply chain transparency, supporting circular economies, and reducing information asymmetry in resource management (Medaglia and Damsgaard, 2020; Jahanshahi et al., 2019; Hessari & Nategh, 2022a). Technological advancements have significant impacts on organizational function and management processes, enabling performance and efficiency optimization (Markopoulos et al., 2019). Blockchain and artificial intelligence (AI) technologies have revolutionized human resources (HR) activities, such as the implementation of intelligent screening systems for graduate hires based on big data (Hegadekatti, 2018; Khaksar et al., 2010) and other processes (Wisskirchen et

al., 2018). HR departments manage various types of information, including employment, training, salary, benefits, health insurance, financial and banking affairs, disciplinary records, and others, which are susceptible to misuse (Asadollahi et al., 2011; Sepahvand et al., 2023). The use of blockchain technology reduces the risk of data breaches and fraud by virtually eliminating criminals' ability to access this data. The decentralized records stored in the blockchain make it impossible for hackers to tamper with the data, and any modifications must be authorized and approved (Zeadally & Abdo, 2019). Industries and organizations require an intelligent system for managing employee recruitment and experience. Human resource management (HRM) systems and recruitment practices have shifted to the internet and computer-based processes. Blockchain technology has emerged as a catalyst for revolutionizing the next generation of HRM (Yeom et al., 2021; Chen et al., 2021; Hashemzadeh et al., 2011; Jahanshahi et al., 2020). However, the adoption of blockchain in HRM will disrupt traditional workflows, including recruitment, talent pool utilization, background checks, employment verification, and employee interactions (Yi et al., 2020; Gheitarani et al., 2022; Asadollahi et al., 2011). Blockchain technology can manage and store employee data, including contractual employees with smart contracts, work and personal information, financial transactions, and payroll systems. It can facilitate cross-border payments by automating real-time exchange rates and jurisdictional parameters, which are novel features (Hessari & Nategh, 2022b; Coita et al., 2019; Pakuhinezhad, 2023c; Pakuhinezhad, 2016; Pakuhinezhad & Atrian, 2024). As a result, it is quite natural for HR managers to be sensitive to the acceptance or rejection of blockchain applications in HRM and consider the use of this technology as one of their priorities (Asghari Moghaddam & Pakuhinezhad, 2024; Chen et al., 2019; Chen et al., 2021). In this regard, this research is an attempt to categorize the applications of blockchain technology in HRM with an interpretive structural modeling (ISM) approach from the perspective of 15 human resource managers in Iranian organizations and businesses.

2.Literature Review

Blockchain is an open, decentralized ledger that records transactions between two parties in a permanent and verifiable manner. Although it gained popularity with the introduction of Bitcoin in 2009, blockchain has many other applications beyond digital currency that affect various aspects of daily life. Start-ups have developed energy apps that have attracted the attention of traditional power industry players, leading to research and demonstration projects (Zheng et al., 2018; Dehghanan et al., 2021; Gheitarani et al., 2023). Private blockchains, also known as distributed ledgers, differ from public blockchains. Nodes in a blockchain can include sensors, stimulators, and compatible devices in microgrids (Pakuhinezhad, 2023b; Asghari Moghaddam & Pakuhinezhad, 2024). Digital technologies such as blockchain can facilitate the deployment of microgrids in developing countries and contribute to achieving universal energy access by 2030, which is one of the Sustainable Development Goals (Kyriakarakos and Papadakis, 2018).

The HR departments of organizations face several challenges in the global internet era, including screening, verifying credentials, and reviewing records to reduce the risk of hiring the wrong candidates (Gong et al., 2021; Hakkak et al., 2016; Nawaser et al., 2014; Moghaddam Asghari et al., 2024). Blockchain technology enhances security in the storage, analysis, and use of human resource data (Michailidis, 2018), and its applications in HRM are increasingly diverse (Pakuhinezhad, 2023a; Nawaser et al., 2015). Researchers have explored several aspects of the relationship between blockchain and HRM. Li et al. (2021) found a positive relationship between blockchain technology and HRM systems, while Mishra and Venkatesan (2021) noted that the views of HR employees and other departments differ regarding blockchain implementation. Christ and Helliar (2021) suggested that blockchain is an effective tool for addressing deceptive and unethical hiring of immigrants. Guo et al. (2021) demonstrated the usefulness of a big data-based intelligent screening system for graduate recruitment. Ingold and Langer (2021) studied the impact of resume format on recruitment behavior, while Jain et al. (2021) investigated the effectiveness of blockchain-based training. Yeom et al. (2021) proposed a blockchain-based employment contract system with encrypted keyword search capabilities to ensure private access to personal contracts. Fachrunnisa and Hussain (2020) argued that blockchain contributes to information processing to reduce the gap between skills and competencies in the workforce (Takalo et al., 2013; Yaghoubi et al., 2011). Chillakuri and Attili (2021) identified five ways in which blockchain simplifies vital processes in HRM. Sherimon et al. (2020)

suggested that blockchain can assist Omani citizens in identifying new job opportunities. Finally, Öncu (2019) highlighted the potential of blockchain as a secure platform for record-keeping and document transactions.

2.1. Summary of blockchain technology applications in human resource management

By examining various researches, we can categorize the applications of blockchain technology in HRM as shown in Table 1.

Table 1. Important applications of blockchain technology in HRM processes

Application of blockchain in human resource management	Resources
1. Recruitment and selection of human resources and talent management	• Michailidis (2018) • Christ & Helliar (2021) • Jain et al. (2021) • Koncheva et al. (2021) • Chen et al. (2019)
2. Management of fake employment certificates	• Khandelwal et al. (2021) • Medaglia and Damsgaard (2020)
3. The system for issuing certificates and scores for educational, skill and development courses	• Jeong, W. Y., & Choi, M. (2019) • Neiheiser et al. (2020)
4. Improving employer branding	• Mishra & Venkatesan (2021). • Levitskaya et al. (2022)
5. Processing salary information	• Chillakuri & Attili(2021) • Coita et al. (2019). • Wisskirchen et al. (2017) • Koncheva et al. (2019)
6. Data security management in performance assessment and management	• Jeong et al. (2019) • Wisskirchen et al. (2017) • Koncheva et al. (2019)
7. Solving the problem of information asymmetry in HRM and risk reduction	• Wang et al. (2017) • Jeong et al. (2019) • Kim & Jeong (2018)
8. Reducing the gap between skills and competencies in the workforce	• Fachrunnisa & Hussain (2020) • Neiheiser et al. (2020) • Kim et al. (2020)

3. Methods

The researcher conducted fundamental research and assessment using a pragmatic view of the phenomena, based on layers of the research onion (Sanders, 2009). An exploratory comparative approach was used to categorize factors, and a library method was followed by a questionnaire for theoretical studies and factor identification. The study's statistical population comprised 15 human resource managers in Iranian organizations and businesses. The study defined an expert as a qualified individual with a minimum of ten years of experience in managing and implementing human resource processes. Purposive sampling was used, and data analysis was conducted using the ISM method with MICMAC software.

3.1. Data analysis and categorization of selected applications by ISM

At this stage, with the help of interpretative structural modeling, eight applications of blockchain technology in HRM processes have been categorized. In this method, the variables related to the problem are usually identified through the four methods of subject literature, in-depth interviews, observations, and the researcher’s expertise.

In this study, the variables and applications were identified using review of subject literature that was mentioned in the previous part of the model. The main dimensions include the following:

1. Recruitment and selection of human resources and management of talents
2. Management of fake employment certificates
3. The system for issuing certificates and scores for training, skills and development courses
4. Improving employer branding
5. Processing salary information
6. Data security management in performance assessment and management
7. Solving the problem of information asymmetry in HRM and risk reduction
8. Reducing the gap between skills and competencies in the workforce

3.2. The second step: filling out the questionnaire and forming SSIM matrix

The questionnaire used a pairwise comparison method to obtain the opinions of experts in the field of blockchain technology applications in HRM. The questionnaire included eight factors obtained in the first stage and were coded by the researcher using V.A.X.O letters. The researchers coded the layers above the main diameter of the matrix (I.J) as indicated in Table 2.

Symbol V: The row factor (i) can be the basis of column factor (j)
Symbol A: The column factor (j) can be the basis of row factor (i)
Symbol X: There is a bilateral relationship between the row (i) and column (j) factor
Symbol O: There is no relationship between these two variables (i-j)

Table 2. Formation of SSIM matrix

	Reducing the gap between skills and competences in the workforce	Solving the problem of information asymmetry in human resources management and reducing the risk	Data security management in assessment and management of	Processing payroll information	Improving employer branding	System of issuing certificates and scores for training courses, skills and development	Management of fake employment certificates	Recruitment and selection of human resources and talent management
Recruitment and selection of human resources and talent management	O	O	X	O	V	V	V	
Management of fake employment certificates	O	O	X	O	X	X		
The system for issuing certificates and scores for training, skills and development courses	A	A	A	A	X			
Improving employer branding	A	A	O	A				
Payroll information processing	X	X	V					
Data security management in performance assessment and management	A	A						
Solving the problem of information asymmetry in human resource management and risk reduction	V							

Reducing the gap between skills and competencies in the workforce								

3.3. The third step: Forming the primary access matrix: The primary access matrix is completed by observing the following four rules (Table 3):

-If the element (i-j) in the SSIM matrix takes the symbol V, the element corresponding to this symbol in the primary access matrix receives 1, and its analog house (j-i) receives 0.
-If the element (i-j) in the SSIM matrix takes the symbol A, the element corresponding to this symbol in the primary access matrix receives 0, and its analog element (j-i) receives 1.
-If the element (i-j) in the SSIM matrix takes the symbol X, the element corresponding to this symbol in the primary access matrix receives 1, and its analog element (j-i) receives 1.
-If the element (i-j) in the SSIM matrix takes the symbol O, the element corresponding to this symbol in the primary access matrix receives 0, and its analog element (j-i) receives 0.

Table 3: Primary access matrix

	Reducing the gap between skills and competences in the	Solving the problem of information asymmetry in human	Data security in management and evaluating	Processing payroll information	Improving employer branding	System of issuing certificates and scores for training courses.	Management of fake employment certificates	Recruitment and selection of human resources and talent
Recruitment and selection of human resources and talent management	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
Management of fake employment certificates	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**0**
The system for issuing certificates and scores for training, skills and development courses	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
Improving employer branding	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
Payroll information processing	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Data security management in performance assessment and management	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**
Solving the problem of information asymmetry in human resource management and risk reduction	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Reducing the gap of skills and competencies in the workforce	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**

To correct the primary access matrix to the final access and to check the effect of variables on each other, Warfield's method was used, namely element-by-element comparison, and the primary access matrix was confirmed.

5.3 The fourth step: categorization of levels

• Developing the categorization table: This table consists of variables, including input set, output set, common set and level. First, the variables are numbered, and the number of each variable is constant until the end of model extraction.

• Input set: It is a set of elements under the column of a variable in the previous table.

•Output set: Elements that are on the front row of each variable in the previous table.

• Level 1 is where the common set and the output set are identical. In other words, it has the highest dependence and is placed above the model. It should be noted that every time we fill this table, we can only specify the level 1 (Table 4).

Table 4. Level 1 categorization

VARIABLE	Level	Common set	Output set	Input set
Recruitment and selection of human resources and talent management		1/2/6	2/3/4/6	1/2/66
Management of fake employment certificates	1	2/3/4/6	2/3/4/6	1/2/3/4/6
The system for issuing certificates and scores for training, skills and development courses	1	2/3/4	2/3/4	1/2/3/4/5/6/7/8
Improving employer branding	1	2/3/44	2/3/4	1/2/3/4/5/6/7/8
Payroll information processing		5/7/8	3/4/5/6/7/8	5/7/8
Data security management in performance assessment and management		1/2/6	1/2/3/6	1/2/5/6/7/8
Solving the problem of information asymmetry in human resource management and risk reduction		5/7/8	3/4/5/6/7/8	5/7/8
Reducing the gap of skills and competencies in the workforce		5/7/8	3/4/5/6/7/8	5/7/8

Determining the level 2: The steps are the same as those of level 1 (Tables 5 and 6).

Table 5: Level 2 categorization

	Variable	Improving employer branding	Solving the problem of information	Data security management in evaluating and	Processing payroll information	Recruitment and selection of human
1	Recruitment and selection of human resources and talent management	**0**	**0**	**1**	**0**	**1**
5	Payroll information processing	**1**	**1**	**1**	**1**	**0**
6	Data security management in performance assessment and management	**0**	**0**	**1**	**0**	**1**
7	Solving the problem of information asymmetry in human resource management and risk reduction	**1**	**1**	**1**	**1**	**0**
8	Reducing the gap between skills and competencies in the workforce	**1**	**1**	**1**	**1**	**0**

Table 6: Categorization of level 2-continued

	Variable	Level	Common set	Output set	Input set
1	Recruitment and selection of human resources and talent management	2	5/7/8	16	1/6
5	Payroll information processing		5/7/8	5/6/7/8	5/7/8
6	Data security management in performance assessment and management	2	1/6	1/6	1/5/6/7/8
7	Solving the problem of information asymmetry in human resource management and risk reduction		5/7/8	5/6/7/8	5/7/8
8	Reducing the gap between skills and competencies in the workforce		5/7/8	5/6/7/8	5/7/8

Steps to determine the level 3: The steps are the same as determining the level 2 (Tables 7 and 8).

Table 7. Level 3 categorization

	Variable	Reducing the gap between skills and competences in the workforce	Solving the problem of information asymmetry in human resources	Processing payroll information
5	Payroll information processing	**1**	**1**	**1**
7	Solving the problem of information asymmetry in human resource management and risk reduction	**1**	**1**	**1**

8	Reducing the gap between skills and competencies in the workforce	**1**	**1**	**1**

Table 8. Level 3 categorization -continued

	Variable	Level	Common set	Output set	Input set
5	Payroll information processing	**3**	**5/7/8**	**5/7/8**	**5/7/8**
7	Solving the problem of information asymmetry in human resource management and risk reduction	**3**	**5/7/8**	**5/7/8**	**5/7/8**
8	Reducing the gap between skills and competencies in the workforce	**3**	**5/7/8**	**5/7/8**	**5/7/8**

After categorizing all eight factors all nine factors are categorized as shown in the following Table.

Table 9: Final categorization

Variable	Level
Recruitment and selection of human resources and talent management	**2**
Management of fake employment certificates	**1**
The system for issuing certificates and scores for educational, skill and development courses	**1**
Improving employer branding	**1**
Payroll information processing	**3**
Data security management in performance assessment and management	**2**
Solving the problem of information asymmetry in human resource management and risk reduction	**3**
Reducing the gap between skills and competencies in the workforce	**3**

5.4 Analysis of influence rate and degree of dependence

After categorization of factors, it is time to specify the influence rate and dependence degree of the factors. The influence rate indicates how much each variable can provide for other concepts or variables; in other words, to what extent the variable can conceptualize. The degree of dependence shows to what extent the realization of each concept or variable should be provided for by other concepts or variables; in other words, how many variable

concepts must have been realized for this variable to exist. Factors that have a high influence rate and a low degree of dependence create the context of other factors or variables (Table 10).

Table 10: Analysis of influence rate and degree of dependence

	Variable	Influence	Recruitment and selection of human resources and talent management	Management of fake employment certificates	System of issuing certificates and scores for training courses, skills and development	Improving employer branding	Processing payroll information	Data security management in evaluating and managing the performance	Solving the problem of information asymmetry in human resources management and reducing the risk	Reducing the gap of skills and competences in the workforce
1	Recruitment and selection of human resources and talent management	5	0	0	1	0	1	1	1	1
2	Management of fake employment certificates	4	0	0	1	0	1	1	1	0
3	The system for issuing certificates and scores for educational, skill and development courses	3	0	0	0	0	1	1	1	0
4	Improving employer branding	3	0	0	0	0	1	1	1	0
5	Payroll information processing	6	1	1	1	1	1	1	0	0
6	Data security management in performance assessment and management	4	0	0	1	0	0	0	1	1
7	Solving the problem of information asymmetry in human resource management and risk reduction	6	1	1	1	1	1	1	0	0
8	Reducing the gap between skills and competencies in the workforce	6	1	1	1	1	1	1	0	0
			3	3	6	3	7	8	5	2

Table 10 shows the analysis of influence rate and the degree of dependence. After this assessment, the final categorization of blockchain technology applications in HRM is shown in Figure 1.

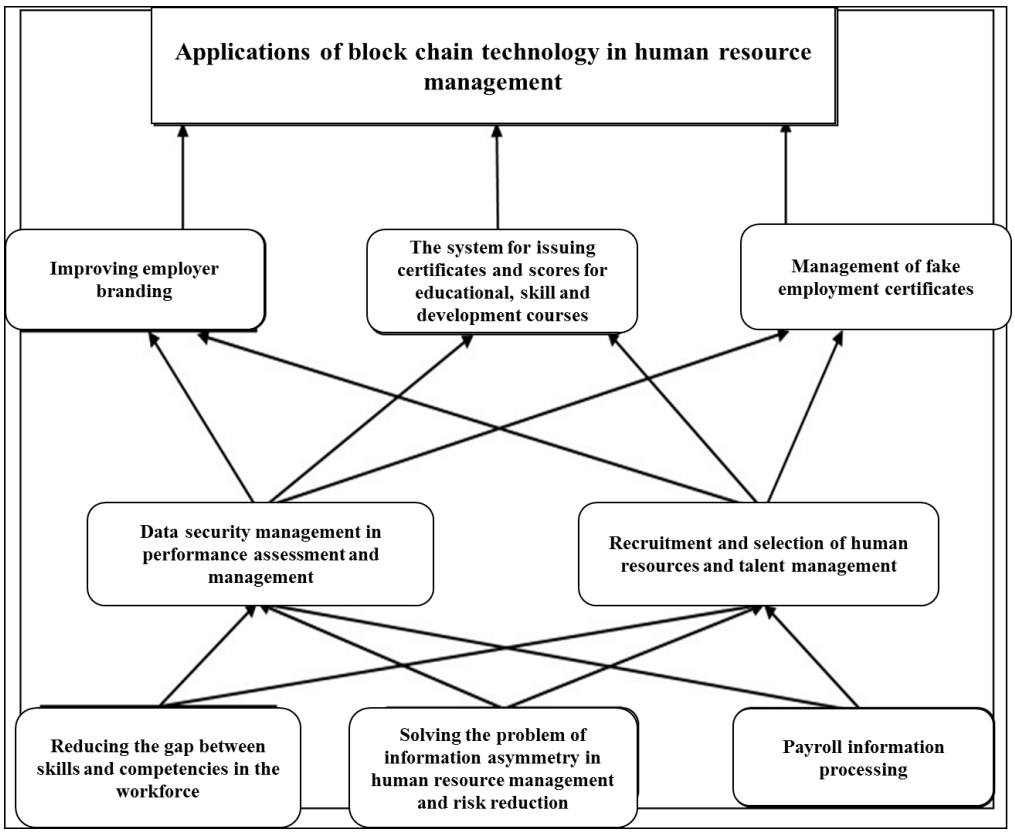

Figure 1: Final Categorization of blockchain technology applications in HRM

5. Discussion, conclusion, and practical implications

Blockchain technology is used for human resources activities in two ways: keeping record of employee's employment history and the mode to access information related to qualifications of current or future staff. With the help of blockchain technology, employers can quickly and easily check the historical records of employees (Yeom, et al., 2021). The issue of fraudulent employment certificates is a longstanding problem in the employment system due to a lack of communication between certifiers and employers. Blockchain technology can provide a tamper-proof register, making it an ideal system for certifiers to record and verify published certificates. Furthermore, this system can verify the real identity of all entities involved, including the user, organization, and certificate issuer. Unlike other government institutions, blockchain technology offers a cost-effective platform for managing the issuance of certificates (Jeong et al., 2019). In blockchain-based HRM, smart contracts can validate the skills, training, learning, expertise, achievements, and performance of future employees to optimize job allocation. This technology benefits organizations by increasing efficiency, reducing the costs associated with HRM, and creating savings. Blockchain technology brings about profits through trustworthiness, identity verification, evaluation of skills and training, and the development of an effective payment system (Neiheiser et al., 2020; Khandelwal et al., 2021).

This paper aims to advance our understanding of the potential applications of blockchain technology in HRM to increase transparency, efficiency, trust, and security in managing employee affairs. We propose three levels of application for blockchain in HRM. Level 1 comprises three important processes: "managing fake job certificates," "issuing certificates and scores for training, skills, and development courses," and "improving employer branding," which is a key concern for human resource managers. Level 2 includes "recruitment and selection of human resources and talent management" and "data security management in performance assessment and management." Finally, Level 3 encompasses "salary information processing to address information asymmetry" and "reducing the risk and gap between skills and competencies in the workforce."

By using blockchain in HRM, all parties involved can participate in updating the skills and knowledge of employees. The information obtained from the blockchain process can also be used as a resource for policymakers to determine competency standards among employees. The HR blockchain enables an automated process to create an agreement between the parties involved. It provides data transparency and access opportunities for employees and company managers without abuse. This allows managers to easily track the performance records of each employee, which can aid in career development and improve the management of employee experience. Future research should focus on operational monitoring of these functions through applied research in real businesses and report their positive and negative results for better development of human resources.

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