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Strategic Prioritization of HRM 4.0 Adoption Barriers: An Integrated ISM and MICMAC Approach for Sustainable Digital Transformation

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Abstract

Purpose- The objective of this study is to explore and examine the most significant challenges to the successful HRM 4.0 implementation in the digital transformation era. Organizations, particularly in developing countries, are grappling with a variety of structural, technological, and behavioral challenges due to the increasing adoption of new technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and data analytics (data analysis), that are now part of Industry 4.0. The goal of this study is to systematically explore such barriers and to identify interrelationships between them, in order to facilitate effective decision-making and policy-making.

Design/Methodology/Approach- The study is designed by a qualitative design, and exploratory type of research, Interpretive Structural Modeling (ISM) combined with MICMAC analysis. A comprehensive literature review (2014-2025) was first performed to find important barriers. Ten key barriers were finalised based on expert validation. A Structural Self-Interaction Matrix (SSIM) was created to establish relationships among the barriers and a reachability matrix was developed, along with the partitioning of the barriers into hierarchical levels. The barriers were also categorized using the MICMAC analysis in terms of driving and dependence powers to prioritize and interpret them strategically.

Findings- The study reveals ten significant barriers, such as infrastructure, resistance to new technologies, cyber security, investment costs, data management, lack of digital strategy, economic uncertainty, low technological maturity, lack of skills and job disruption. The lack of infrastructure and resistance to technology are the most influential driving barriers, which in turn may lead to several dependent problems as shown by the ISM model. The barriers identified are more economic, skill related and job disruption in nature. The classification of barriers as driving and dependent barriers is supported by the MICMAC analysis which shows that they have a hierarchical impact on each other and are interconnected.

Practical Implications- The result indicated that the key factors for successful HRM 4.0 implementation in the organizations are infrastructural development, workforce reskilling and strategic digital planning. Commitment of leadership, an effective change management process, and cybersecurity frameworks are crucial. Further, the government can play a role in enabling digital readiness and capacity building, especially in SMEs and developing economies, by undertaking initiatives such as Skill India and Digital India.

Originality/Value- The research proposed in this paper is based on the idea of having a structured framework for the interrelationships of the barriers of HRM 4.0 adoption, which is missing from the literature. This article presents a comprehensive hierarchical model of the barriers that supports the formulation of specific policies for sustainable digital transformation and competitive advantage, as opposed to previous research that investigated barriers individually.

Keywords: HRM 4.0, Industry 4.0, ISM, MICMAC, Digital Transformation, Transitivity, Analytics.

1. Introduction

Industry 4.0 has influenced the traditional approaches to business by introducing the idea of cyber-physical system, Internet of Things (IoT) and artificial intelligence (AI) to the process of business production and service delivery. In the meantime, the concept of Human Resource Management (HRM) has been turned in a new direction and is currently called HRM 4.0 the fully innovative paradigm of decision-making, grounded in data, the automation of routine processes, or the human-AI partnership, which is supplemented with the digital assistive. It has a great potential, but the successful implementation of the HRM 4.0 is associated with a set of structural issues, in particular, in the developing economies. Major initial investment requirements, the absence of the IT infrastructure, the existence of the communication gap between the operational and information technologies are the continuous problems (Kumar and Krishna, 2025; Ben Ruben et al., 2023). The organizational inertia, lack of technology among the staff, and the lack of knowledge about digital technologies further aggravates the matter (V. K. et al., 2023; Pillai et al., 2021). In particular, the reformation in the sphere of the state administration is not effective in the areas of post-socialism Europe; despite the modernisation of the processes, they are blocked by the historical heritages and politicisation of the institutions (Poljašević et al., 2025). Moreover, the non-availability of resources and an adequate process management system are the problems of the SMEs to integrate HR and operational processes (Kahveci et al., 2025). The deficit of cyber-physical components and improperly developed communication criteria decrease the effectiveness of the operations and crunch down the process of the digital transformation (Ben Ruben et al., 2023).

Additionally, the unsuitability with the implementation of AI into the human-centered HR services introduces additional issues. Modern world has witnessed massive advancement in the sphere of automation; however, along with its theoretical opportunities, there are practical gaps in the present-day situation of utilizing AI as the means of extending the power of human beings rather than surpassing it (Bindra et al., 2025). Both the employees and the managers experience both psychological and behavioral resistance to the work due to antiattitudinal emotions, unclear value propositions and lack of employment security (V. K. et al., 2023; Pillai et al., 2021). It also has research where the breakdown of managerial and technological readiness, where strategic management, and training show disrespect to the digital disruption (Ruben et al., 2023; Dixit and Kumar, 2024). The dedication of the top management and the properly structured employee development programs will become the key to success in the digital transformation of the HR (Eger & Zizka, 2024). COVID-19 pandemic also accelerated the rate of digital transformation and disclosed the flaws of the system, such as the lack of digital proficiency, unwillingness to work remotely, and the use of obsolete management strategies (Eger and Žižka, 2024). The interrelationships among the barriers have also been adequately described by such structure of strategy as ISM (Interpretive Structural Modeling) and MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) to find out the drivers of transformation (Dixit & Kumar, 2024). Moreover, the review of existing literature on HR analytics suggests that the variety of factors that are yet to be filled in the successful transition to the HRM 4.0 as leadership engagement, technological adaptation, and people-oriented innovation (Wang et al., 2024). In the national level, like in India, hybridizations have been applied to categorizing the HRM-related barriers according to the dimensions of management, procedural, operational, and behavioral levels of performed industries such as automobile manufacturing (Virmani et al., 2021; A. James et al., 2022). In that sense, to overcome these multi-dimensional problems, the strategies that target the working collaboration of the government, the investment of infrastructure and training of the employees on a selective basis will have to aid in the defeat (Kumar & Krishna, 2025; Dixit and Kumar, 2024). As the organizational environment has been changing due to the digital transformation, it is required to take a closer look at the structure, which will outline the existing barriers to adopting HRM 4.0.

2. Research Objectives

This makes strategic adaptation and ethical mind more of a point in the haste of changing over to digital. It is evident that the aim of the initiative is to seal this gap through the identification and testing of some of the variables that serve as barriers to implementation of HRM 4.0. Further, more narrowly, the research goals are triple:

1. To determine the impediments to the application of HRM 4.0 that were reported by recent research.

2. Delineating the appropriate relationship and learning the correlation of and effects of these barriers against each other with Interpretive Structural Modeling (ISM) to construct a multi-hierarchal model.

3. To determine barriers that have strong motivators that can be determined using the model and offer a frame that will determine specific implications of the management and policy to address the same.

The analysis of the identified barriers that were found in the literature review is the first part of the paper. The second part is the discussion of the Interpretive Structural Modeling approach; this part outlines, displays and discusses this approach. In this section, the extent of relationship between the model-building process and the barriers is highlighted. Finally, the paper concludes with the findings, arguments, conclusions as well as limitations.

3. Barriers Identification

The barriers are established following literature review. In the framework of our review, we took into account the literature on HRM 4.0, where the publications are released within the past decade, to be more precise, between 2014 and 2025. It has just taken into account academic materials of books on production, supply chains publications, business magazines, book chapters and white papers. The literature search was done using only English language and hence only books, magazines and journals were used. The majority of the articles were obtained at the databases like Scopus. The search was made using such keywords as Industry 4.0, block chain, sustainability development, artificial intelligence, big data analytics, HRM 4.0, Internet of things (IoT), and Digital HRM. It was possible to find 273 articles in these databases with these keywords. The abstracts of such 273 papers were then read. Out of the total number of 273 papers initially, 70 papers were thought to be applicable in the study relating to the barriers or challenges in the use of HRM 4.0. The 70 articles were referred to in finding the barriers and provided background to the discussions of the expert panel. The following sections are able to conduct detailed review on the 10 barriers to adoption of HRM 4.0 that are identified. The literature at hand identifies many impediments to adoption of an HRM 4.0 such as resistance to technology, infrastructural gap, and shortage of skills. Figure of analysis is however the isolated way that challenges are usually analyzed and people are not mindful of interconnections. It is becoming more crucial that these barriers need to be holistically addressed and structured so that future digital HR transformation could be successful.

3.1 Lack of Infrastructure (R_1)

The main barrier to an effective integration of Industry 4.0 technologies, Circular Economy and Green Human Resource Management is the insufficient level of infrastructure, especially among small and medium size enterprises (SMEs). This weak infrastructural base inhibits the implementation of higher-order digital technologies and sustainable models of the production necessary to gain maturity in the industry 4.0 (Miller et al., 2024). The lack is aggravated by the high cost of investments and the difficulty of coordinating operations technologies with information systems, and this generates a technological gap and dampens the digital transformation process (Kumar & Krishna, 2025). Also, the insufficient infrastructure hinders the efficacy of the process management since the latter is essential in aligning the human resource strategies and operational models (Kahveci et al., 2025). Possible changes are suggested on the basis of comprehensive readiness models and strategic roadmaps to measure infrastructural readiness and facilitate the transition, yet both tools will not work without a basic technological framework (Ansari et al., 2025). Such frameworks as the enhanced Technology-Organizational-Environmental-People (TOEP) model provide the opportunity to outline the main infrastructural enablers, but the way they can be implemented all depends on the state involvement and investments into the digital infrastructure (Mishra & Pathak, 2024; Dixit & Kumar, 2024). Elimination of infrastructural obstacles, therefore, is crucial when it comes to realizing organizational resilience and an environment of sustainable competitiveness.

3.2 Resistance to Adopt New Technologies (R_2)

The opposition to the use of new technologies is still an important barrier to the adaptation of Industry 4.0 and 5.0 in the manufacturing and textile industries. Although the transforming ability of blockchain, IoT, and AI technologies to increase traceability, customization, and sustainability is huge, organizations often have to face internal resistance, especially when employees are either ill-equipped or unwilling to embrace change (Kumar & Krishna, 2025). It is particularly high in the workforces that are multigenerational and involve a variety of expectations and the degree of flexibility thus breeding reluctance to adoption of any technological improvement (Salvadorinho et al., 2025). Moreover, the establishment of human-cyber-physical systems in the industry 5.0 necessitates an extension in the organization culture to be more humanistic and collaborative, which may be encountered with reservations or even denial (Lou et al., 2025). The lack of infrastructure, and digital skills, as well as the fear of losing the job, tend to compound the personnel resistance (Attiany et al., 2023). The resistance is aggravated by the absence of preparedness and management support in the SMEs where operational priorities are more important than the strategic innovation (Muller et al., 2024). Consequently, overcoming this obstacle will require active intervention approaches, such as participative decision-making, sponsorship programs, and lifelong learning so that a technologically robust and flexible workforce can be developed.

3.3 Cyber security Challenges (R_3)

Implementation of Industry 4.0 technologies in the organizational structure poses a serious challenge in terms of cybersecurity, and this aspect is linked to both the connectedness of the smart systems and the automation trend to apply to more digital threats. The concept of sustainability via the principles of a circular economy and green HRM introduces the role of cybersecurity as one of the essential obstacles in organizations, particularly in cases of information sensitivity, e.g., health education (Singh et al., 2025). These are aggravated with the digitalization of small and medium enterprises (SMEs), and the problem of IT security instead of limiting innovation has become the trigger of implementing complex technologies (Arroyabe et al., 2024). Although machine learning is capable of significantly resilient cybersecurity entailing the superior threat detection and risk evaluation, constant threats that may affect the data manipulation entail more flexible and adjustable frameworks (Yu et al., 2024; Toussaint et al., 2024). Additionally, the lack of cybersecurity management is compounded by business impediments such as organizational obstacles to the adoption of Industry 4.0, and organizational obstacles entailing communication gaps and staff resistance, which complicate the adoption of Industry 4.0 (Kumar & Krishna, 2025). It is important to overcome these barriers in a bid to make technology advancements coordinate with safe and sustainable growth.

3.4 High Investment Requirements (R_4)

The major challenge to the adoption of Industry 4.0 technologies, particularly by small and middle-sized enterprises (SMEs), is the high cost of investment and this is one of the most recurrently reported difficulties. This economic setback hinders the efforts of most businesses to integrate newer forms of technology since most industrial facilities may require a lot of capital up-gradation, purchase of goods, and human resource training (Kumar & Krishna, 2025; Ingaldi & Ulewicz, 2025). These factors make it challenging to engage in the industry 4.0 transformation since resources-limited firms have to invest in both digital integration and acquisition of new competences simultaneously (Thurein Lin & Liangrokapart, 2025). Solutions to deal with these issues can include strategic interventions like supply chain finance (Gunasekaran et al., 2024), government sponsored financial assistance, and collaborative platform whereby SME can share technological resources (Ingaldi & Ulewicz, 2025). These solutions will be critical to minimise the entry barriers presented by the high cost of investment and allow an even distribution of the opportunity to benefit by embracing digital transformation in the manufacturing industries.

3.5 Data Management and Quality Challenges (R_5)

The problem of data management and quality serves as one of the key impediments concerning the successful execution of the industry 4.0 and Healthcare 4.0 technologies, especially when its implementation concerns the realm of sustainable development. These issues prove of particular importance in the process of merging Industry 4.0 technologies with the principles of the Circular Economy and Green Human Resource Management (Singh et al., 2025). It is also critical to note that managing complexities in operations including working with large amounts of data in industrial operations plays a significant role in supporting applications in Maintenance 4.0 that require intelligence and the Internet of Things to enhance energy levels and optimize systems (Freitas et al., 2025). Nevertheless, constraints in the quality of data, systems interaction, and the transparency of models still limit more usage (Shaban et al., 2025). Such problems are also aggravated by both technical and human resource problems, such as employee resistance, the lack of communication between operational and informational digital technologies (Kumar & Krishna, 2025). Moreover, within the domains of healthcare and agri-food supply chains, data quality and not having an effective data infrastructure are the leading issues (Attiany et al., 2023; Derakhti et al., 2023), particularly in developing countries that need holistic solutions (Kumar et al., 2023).

3.6 Lack of Digital Strategy (R_6)

One of the most significant barriers to digital transformation within organizations is the absence of a digital strategy because it results in the inability to have a clear vision and a poor knowledge of strategic priorities. According to Attiany et al. (2023), one of the most basic challenges that do not allow organizations to integrate digital technologies successfully is the need to develop an integrated digital strategy. Such a barrier manifests itself most strongly in the case of asset management, where companies can easily get in the rut of digitalization as they lack strategic direction and understanding of their digital goal (Maletič et al., 2023). In addition, there is no strategy which promotes the negative attitudes of people towards technologies as well as add to the uncertainty of the concretized advantages of digital transformation, further encouraging them to adopt it (V. K. et al., 2023). To overcome this obstacle, companies are to seek effective formulation of the digital strategies that will reflect long-term priorities and, in this way, facilitate a more ordered and goal-oriented transformation process.

3.7 Uncertainty of Economic Benefits (R_7)

The increased lack of certainty with regards to economic gains is one of the major barriers to the implementation of Industry 4.0 technologies, as the organizations may not be able to justify the necessary capital expenditure efficiently without the presence of unquestionable economic outcomes. The source of such economic uncertainty is that returns on technological integration show a high level of irregularity; hence, firms become reluctant to implement such systemic changes (Knoke et al., 2025; Lin & Liangrokapart, 2025). Organizational and managerial limitations add to such uncertainties and aggravate the process of adopting strategic decisions (Lin & Jirapan, 2025; Turan & Elif, 2025). Although there are possible rewards like better efficiency and competitiveness, economic obstacles are still the key issue (Szuwar, 2024; Herrera et al., 2024), and additional economic models and risk management approaches focusing on supporting investments in Industry 4.0 will be necessary.

3.8 Low Maturity Level of Technology (R_8)

The mechanical maturity of technology is still a major setback in the implementation of the industry 4.0 technology in various industries. Most of the organizations, especially those in the developing world are suffering in how they integrate the immature technology provider and legacy systems which are not sophisticated enough to support the digitalization (Kannan et al., 2024; Ślusarczyk & Wiśniewska, 2024). Even though the strategic value of data has been acknowledged in the paper industry, technologies are hampered by irregularity in digitalization and low quality of the data (Othen et al., 2025). Australian construction industry is characterized by the tendency to rely on old proven technologies, which means that the industry is not inclined to implement a new but unproven technology (Perera et al., 2025). Moreover, low technology maturity is worsened by employee resistance, lack of interconnection between the operational technology and the informational technology, and the great cost involved in the implementation (Kumar & Krishna, 2025). To deploy the given barriers, workforce upskilling, specific maturity models, and infrastructure enhancement, supported by the government, will be needed (Sajjad et al., 2024).

3.9 Lack of Adequate Skills (R_9)

Inadequate skills level is one of the most important barriers to successful adoption of the industry 4.0 technologies, especially in small industries facing resource scarcity (Kumar et al., 2025). This disengagement makes it challenging to employ advanced technologies efficiently and leads to the lack of willingness to change among workers in general (Attiany et al., 2023). To negotiate this skills gap, it is essential to develop digital-technical competencies, industry-specific competencies, cognitive and business competencies as Marlapudi and Lenka (2025) emphasize. Furthermore, other institutional pressures, namely coercive, normative, and mimetic forces also serve as a central aspect to the improvement of workforce capabilities in developing nations, including Bangladesh, and thus help support the adoption of Industry 4.0 (Alam & Dhamija, 2022). The effective transition can be also enabled by Human Resource Management (HRM) based on its responsible practices, such as talent management, strategic cooperation, and change leadership (Mukhuty et al., 2022).

3.10 Job Disruptions (R_{10})

Job disruption is one of the most important challenges to the application of Industry 4.0 in the human resource field and presents itself in the form of employee resistance to change, skills mismatch, and doubts concerning economic returns (Attiany et al., 2023; Mukhuty et al., 2022). A digital skills gap and expensive technology adoption have also been identified as an additional barrier in this framework. In order to address these obstacles, companies should institute the practice of socially responsible HRM, including strategic partnerships and end-to-end talent management, as the means of maneuvering through the transformations of work (Mukhuty et al., 2022). The key to handling such disruptions is collaborative development of new HR practices initiated both by the managers and HR professionals (Yalenios & dArmagnac, 2022). It is also essential to mitigate economic barriers since they spill over to other spheres, increasing the chances of job disruption (Sayem et al., 2022). Moreover, the optimism of employees, quality digital leadership, responsible application of AI, and state assistance may help reduce discontinuity and promote sustainable transformation of HR (Singh & Pandey, 2024; Kumar & Krishna, 2025).

Although the body of literature before stresses on several personal problems that give rise to the implementation of HRM 4.0, there is a limited attempt to reveal the hierarchical interrelations of these obstacles by utilizing analytical frameworks. Lack of combined systems restricts strategic decision-making on companies undergoing digitalization of HR operations. This research fills that gap as it uses Interpretive Structural Modeling (ISM) and MICMAC analysis in mapping interdependencies of barriers. It also presents a systematic plan of addressing the barriers that can be a priority and offer some stepping stones to ensure policymakers, HR leaders, and organizations take some steps in ensuring sustainable HRM 4.0 implementation.

4. Methodology

The research design of this study is based on a qualitative and exploratory research design with the help of Interpretive Structural Modeling (ISM) and MICMAC analysis to critically analyze the barriers to the implementation of HRM 4.0. First, a comprehensive literature review was performed based on the peer-reviewed journals, books, reports, and conference proceedings that were published in 2014 to 2025 in order to specify the barriers of interest. Based on this review, ten problematic barriers were shortlisted. A panel of experts, consisting of academicians, HR specialists and industry practitioners who have undergone the digital transformation process, was then formed to authenticate the found barriers and create contextual associations among them. A Structural Self-Interaction Matrix (SSIM) based on expert judgments was created to reflect pairwise relations between the barriers and this was later converted to an initial and final reachability matrix, where the concept of transitivity was applied. Level partitioning was then done based on the finalized reachability matrix and a multilevel hierarchical ISM model was created to show the driving and dependent nature of each barrier. Additionally, MICMAC analysis was used to categorize the barriers into driving, dependent, autonomous and linkage as per the driving power and dependence. This combined methodological framework allows an organized knowledge of interrelationships between complex interrelationships among the barriers in the field of HRM 4.0 and allows strategic prioritization to enhance the digital HR transformation.

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5. ISM Methodology

The Interpretive Structural Modeling (ISM) is a technique that helps to define and organize the relationships between complex factors in a system. It supports hierarchical modeling with the help of experts that provides a more efficient decision-making. ISM also incorporates such methods as Nominal Group Technique into idea generation (Janes, 1988).

5.1 Step 1 Create Structural Self-Interaction Matrix

The initial phase of the ISM methodology, the so-called SSIM, employs the research respondent's opinion of an expert panel in establishing the relationship that exists between the obstacles that have been witnessed.

To establish a connection between barriers and be able to discuss it with the expert panel ten experts were invited. The selected experts were informed one and a half weeks before the meeting to have time to determine the obstacles that were already presented in the available literature to organize the discussion. To identify a pairwise attachment between the obstacles, SSIM has put into consideration the views of these specialists. By taking barriers i and j, respectively, with four symbols, (V, A, X, and O) such correlations were arrived:

5.2 Table 1: Pair Wise Relationships

Barriers	R_{10}	R_9	R_8	R_7	R_6	R_5	R_4	R_3	R_2	R_1
R_1	O	X	A	O	X	O	V	X	X	
R_2	A	X	V	V	A	O	V	X		
R_3	O	V	V	O	V	A	A			
R_4	O	O	V	O	O	V				
R_5	O	V	V	O	V					
R_6	A	X	V	O						
R_7	A	O	V							
R_8	A	O								
R_9	A									
R_{10}										

- V indicates that the row element influences the column element.
- A indicates that the row element is influenced by the column element.
- X indicates that there is mutual influence.
- Indicates no direct relationship.
- "i" is for rows
- "j" is for columns

Rules:

Symbol	Influence Type	Row i, Colm. J	Row J, Colm. i
V	'Barrier i influences j'	1	0
A	'Barrier j influences I'	0	1
X	'Mutual influence'	1	1
O	'No influence'	0	0

This table summarizes how each symbol affects the values in the matrix.

where the barriers are numbered 1-10 and the values of the i and j represent them. Additionally, the results are tabulated to come up with a pair-wise relationship to bring about an end to the identification of the barriers as shown in Table 2.

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5.3 Table 2: Initial Reachability Matrix

Barriers	R_{10}	R_9	R_8	R_7	R_6	R_5	R_4	R_3	R_2	R_1
R_1	0	1	0	0	1	0	1	1	1	0
R_2	0	1	1	1	0	0	1	1	0	0
R_3	0	1	1	0	1	0	0	0	0	0
R_4	0	0	1	0	0	1	0	0	0	0
R_5	0	1	1	0	1	0	0	0	0	0
R_6	0	1	1	0	0	0	0	0	0	0
R_7	0	0	1	0	0	0	0	0	0	0
R_8	0	0	0	0	0	0	0	0	0	0
R_9	0	0	0	0	0	0	0	0	0	0
R_{10}	0	0	0	0	0	0	0	0	0	0

5.4 Step 2: Formation of Reachability Matrix

Table 2, below, depicts the original reachability matrix that was used as a finding based on Table 1. The binary representation of 1s and 0s is used to provide a display of the matrix due to specific set criteria (Jharkharia & Shankar, 2004; Harland, Lamming, Zheng, & Johnsen, 2007).

Using the initial reachability matrix (Table 2) final reachability matrix is derived and is as Table 3 shows. This matrix is founded on the concept of transitivity. The last reachability matrix reveals the existence of transitivity as well as illustrates Table 3. Each barrier dependency and the driving force was calculated on top of each other (both horizontally and vertically respectively) to come up with a final reachability matrix (Table 3) as shown in Table 4.

5.5 Step 3: Level Partitions Using Iteration Methods

Final reachability matrix (Table 3) has been used in order to generate the reachability set (R) and antecedent set (C) of each of the barriers that have been identified. The next step to be performed is the generation of each barrier with the intersection set of the sets i.e (R∩C) is generated.

Table 3: Final Reachability Matrix

Barriers	R_{10}	R_9	R_8	R_7	R_6	R_5	R_4	R_3	R_2	R_1
R_1	0	1	1	1	1	1	1	1	1	0
R_2	0	1	1	1	1	1	1	1	0	0
R_3	0	1	1	0	1	0	0	0	0	0
R_4	0	1	1	0	1	1	0	0	0	0
R_5	0	1	1	0	1	0	0	0	0	0
R_6	0	1	1	0	0	0	0	0	0	0
R_7	0	0	1	0	0	0	0	0	0	0
R_8	0	0	0	0	0	0	0	0	0	0
R_9	0	0	0	0	0	0	0	0	0	0
R_{10}	0	0	0	0	0	0	0	0	0	0

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6. MICMAC

MICMAC analysis will be useful in sorting the barriers into categories based on their driving power, the number of barriers they touch on and the power of dependence or the number of barriers they are touched on by. Matrix The use of MICMAC analysis can assist one to identify key hindrances that are either highly influential (drivers) or highly dependency hindrances.

6.1 Table 4: MICMAC Analysis Results

Barriers	Driving Power	Dependence Power
R_1	8	0
R_2	7	6
R_3	3	7
R_4	4	2
R_5	3	5
R_6	2	3
R_7	1	2
R_8	0	2
R_9	0	1
R_{10}	0	0

Where the reachability set (R) and the precedent set (C) can be compared and would occupy the highest level in the model only, does an iteration method in selecting the levels to develop the model of ISM be performed. The top-level barriers of the model will not influence any of the barriers that might still exist on a higher level. Once the top-level barriers have been identified, they are separated out of the so-called primary iteration method. In four repetitions, the ten barriers as divided into four levels are as follow: P1: = {R6}; P2: = {R1, R5, R10}; P3: = {R2, R3, R7, R9}; P4: = {R4, R8}

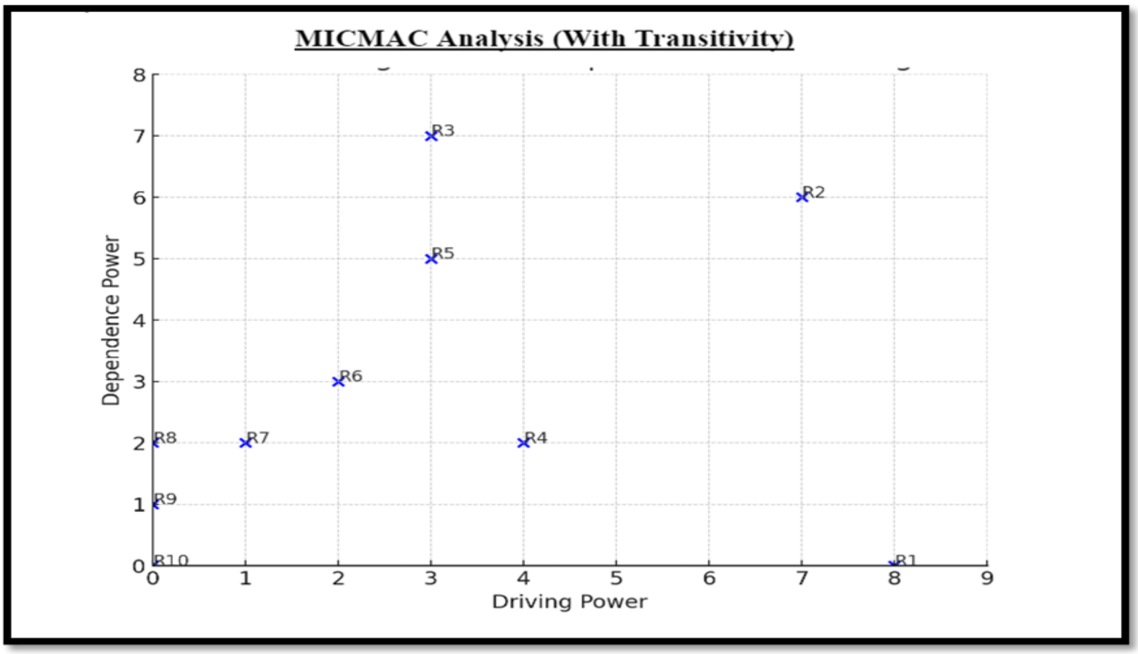

Figure 1 Diagraph

The level partitioning based on the 'Reachability Matrix' with transitivity is as follows:

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Level I: R_1 (Lack of Infrastructure)

Level II: R_2 (Resistance to Adopt New Technologies)

Level III: R_4 (High Investment Requirements)

Level IV: R_3 (Cyber security Challenges), R5 (Data Management and Quality Challenges)

Level V: R_6 (Lack of Digital Strategy)

Level VI: R_7 (Uncertainty of Economic Benefits)

Level VII: R_8 **(**Low Maturity Level of Technology**),** R9 **(**Lack of Adequate Skills), R10 (Job Disruptions)

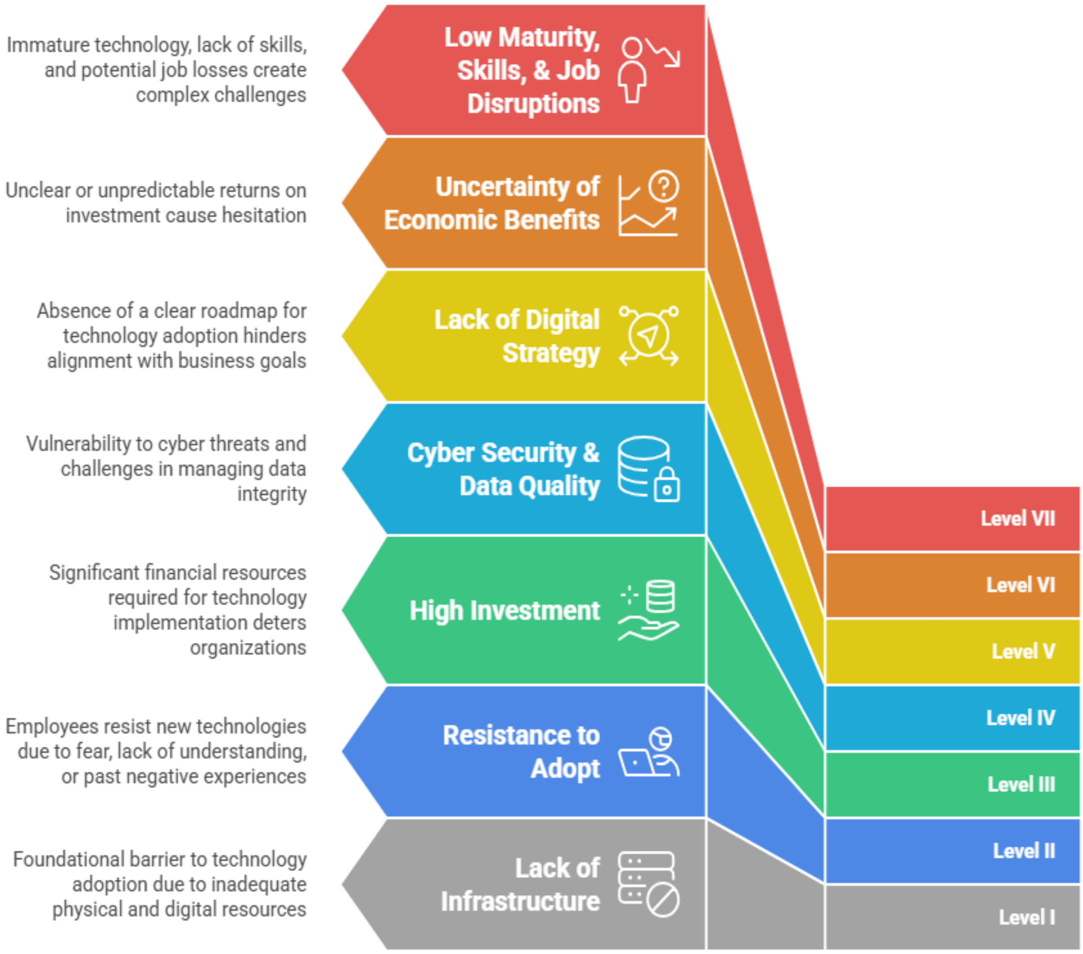

Figure 2: Multilevel Hierarchy Structure ISM based Model

6.2 Step 4: Formation of Driving Power Dependence

Dependency is the sum of barriers which are culpable in such impediment as well as the driving power is the sum of barriers which an obstruction may be. The conclusions to the driving power and dependence are presented in the table 4 below. R1 and R2 are independent barriers since they both have an enormous driving force, and they do not require dependency. Dependent barriers (R3, R5, R6, R7, R8 and R9) are defined to possess high dependency and weak driving force. The barrier R10 is an R signature with weak dependence and driving capacity thus portrayed as an autonomous barrier. No barrier of linking was seen. However, the plot of such findings made with the help of the set of the of the above features can be defined in accordance with the proposals of the historians who are called respectively J. W. Warfield (1974) and J. N. Warfield (1982). The intervening barrier was not established.

6.3 Step 5: Formation of ISM Based Multilevel Hierarchy Model

The ISM-based model shown in Fig. 01 demonstrates the hierarchical dependence of the barriers to the use of HRM 4.0 identified based on expert opinion, and with the help of the systematic analysis. In this model every barrier is placed in a certain level in regard to its driving power (its impact on other barriers) and its dependence power (the extent to which it is affected by others).

7. Results and Discussion

This paper found that the 10 key barriers to success in implementing HRM 4.0 presented a hierarchy discovered via Interpretive Structural Modeling (ISM) and confirmed by MICMAC analysis as well. The findings also reiterated the fact that these barriers do not exist in a vacuum but they are closely connected with each other, establishing a sophisticated ecosystem of requirements and motivators.

- The basis of this model is the lack of infrastructure as a factor that turned out to be the most powerful driver. Many organizations, especially small and medium-sized firms, suffer problems with the obsolescent IT systems, poor digital technologies systems, and poor cybersecurity. The tight technological backbone is never going to permit any futuristic endeavors at the digital transformation of HR.
- Another high-driving barrier emerged as resistance to new technologies adoption. Such reluctance may be caused by the cultural inertia, fear of employees in respect of losing their jobs and the lack of digital literacy. Automation will replace me or I am not comfortable with the new system and this leads to stagnation in an organization. This resistance is often compounded by the lack of utilization of change management strategies and training programs which are often ill-designed.
- The high investment requirement of HRM 4.0 is also characterized as another major barrier. Embarking in the assimilation of innovative technologies too will require high capital expenditure, say in infrastructure, hiring skilled/talented people, training, and system integration. This proves to be an added burden to organizations which are smaller in size and do not have financial reserves. This is made even worse by the existence of the following barriers; barriers to cybersecurity, data management ineffectiveness, and absence of digital strategy, which all translate into an even greater unwillingness to transition to digital HR paradigms.
- Specific solutions such as economic uncertainty, immaturity of the technology, poor labor skills and disillusion were issues at the higher levels of dependency and were found to be outcomes of the problem rather than cause. Such dependent barriers pave the way to an even more complicated environment of digital HR transformation, which highlights the demand to provide a gradual and well-supported implementation of a digital HR transformation. ISM model aided in making a clear distinction of which barriers to be dealt with at once (drivers) and which ones will be the outcomes that will be solved due to the impact of foundational challenges.

8. Strategic Policy Implications

The transformation of HRM 4.0 marks a very important paradigm shifts in organizations living in the digital age but its implementation in practice is still impaired by multiple-layered challenges to structure and strategy that necessitate analysis and intervention through policy.

1) One of the key challenges is the lack of digital infrastructure and outdated HR systems, along with the high cost of adopting HRM 4.0, which creates a major obstacle for organizations in their quest for transformation. These challenges are especially prominent for small and medium enterprises (SMEs) and require financial incentives, shared digital platforms and digital readiness programs supported by the government.
2) One of the biggest challenges for digital transformation is human & organizational resistance. From an employee perspective, there are concerns about job loss due to automation and a lack of digital literacy and

managerial buy-in which diminishes the acceptance of HRM 4.0 practices. To develop a digitally competent workforce, it is crucial to engage in effective change management, participative leadership and regular reskilling and upskilling initiatives.

3) With the rise of HRM 4.0, cybersecurity and data governance are now top priorities. Implementing effective cybersecurity measures is crucial to safeguarding employee information, including the establishment of comprehensive cybersecurity protocols, secure data integration processes, effective governance frameworks, and adherence to privacy laws and regulations. Cyber security measures play a significant role in maintaining the confidentiality, integrity, and proper use of employee information, including the implementation of robust cybersecurity protocols, secure data integration processes, effective governance frameworks, and compliance with privacy regulations and laws.

4) Adoption of HRM 4.0 is dependent on strategic planning and policy alignment. There are a number of organizations whose digital transformation plans are not clearly defined and are not sure of the return on investment (ROI) of sophisticated HR technologies. Structured implementation roadmap, measurable performance indicators, and syncing organizational strategies with national initiatives like Digital India and Skill India Mission can have a tremendous impact on improving the outcomes of implementation.

5) The ISM–MICMAC method used in this study can be used to provide the hierarchical relationships between the main barriers affecting the HRM 4.0 adoption. The framework creates a distinction between driving and dependent barriers, allowing organisations to focus on the most important problems, to allocate resources effectively and to develop digital transformation strategies based on evidence.

6) The study makes a significant theoretical and practical contribution by bringing together a roadmap for researchers, policy makers and managers in organizations to tackle implementation issues associated with HRM 4.0. The results are expected to facilitate sustainable digital transformation, boost the competitiveness of organizations, foster staff development and support the implementation of new and innovative HR practices in the industry 4.0 context.

9. Conclusion

The shift to HRM 4.0 is not only necessary but a strategic change of organizations that would like to stay competitive in the digital world. Nevertheless, this transition is hampered by major impediments which include; poor infrastructure, resistance on the part of employees and a very high cost of investment. The solution to such challenges ought to be a combination of technological preparedness, effective leadership, reskilling employees and favorable public policy. With the support of ISM analysis, all focus should be given on the basics of drivers to establish a stable road to digital HR excellence. Thus, the current study can be used as a guideline by the HR leaders and policymakers to guide the joint investment in the transition of HRM 4.0.

10. Limitations of Study

- The research utilized only the literature review and might not reflect the actual challenges relating to and facing an industry at any one time.
- It is important that surveys or interviews with industry leaders be conducted in the future (to get practical knowledge).
- ISM model is based on the input of very few experts only, which makes it not so applicable in general.
- The reliability of the model must be privileged with validation through large-scale empirical data.

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