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Review

Research Trends in Workforce Planning in the Automotive Sector: A Comprehensive Review

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Abstract: *Background/Purpose:* As the automotive industry continues to develop due to technological advancements, so too do the challenges connected with globalization of operations and the strategic management of human resources. Therefore, our objective was to map the current research work performed for the period of 2014–2024. Moreover, we conducted a comprehensive analysis regarding emerging topics related to strategic human resources, workforce planning and forecasting, employee wellness, and reskilling/upskilling. *Study Design/Methodology/Approach:* The methodology used for this review was a Systematic Literature Review, following the PRISMA protocol to remove biases in the review. The search keywords were: workforce planning, strategic HR, skills, employee wellness, and upskilling. In total, 180 articles were retrieved from SCOPUS. *Findings:* We found that the scholarly work over the year has fluctuated, showing an overall increasing trend of scientific production. The principal themes discussed were 'human, ergonomics, and industrial research'. The research trends were: leadership, knowledge management, innovation, skills, and COVID-19. We concluded that most of the impact on employee satisfaction and upskilling is on an operational level. *Originality/Value:* Furthermore, our comprehensive review offers theoretical and practical implications in line with the COVID-19 impact and HR strategies.

Keywords: trends; productivity and satisfaction; HR strategies; workplace; automotive industry; automotive sector; comprehensive review

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1. Introduction

The automotive sector impacts the demands in the upstream and downstream industries, which are evolving due to technological advancements in autonomous vehicles, the globalization process, and workforce diversity. The industry contributes to job creation and employment opportunities. An example of this is the European Union, where 13.8 million are employed in the automotive sector, 3.5 million in manufacturing, 4.5 million in sales and maintenance, and 5.1 million in the production, distribution, and sales of automobiles (European Commission, 2024).

The fast-evolving workplace variables, such as self-control, employee potential recognition, and team cohesion, can offer a more human-centered management approach as supported by Pan et al. (2024). In addition, Contreras et al. (2024) identify a gap in the exploration of human factors that can be fundamental for HR practices. A human-centered management approach to digital HRM can have a positive contribution to technological

advancement in employee engagement, satisfaction, and well-being, rather than being efficiency- and cost-oriented.

In their review paper, Hohenstein et al. (2014) analyzed the issues in SCM from 1998 to 2014, predicting a growing trend in human resource management and Supply Chain Management challenges. The challenges in the automotive industry are the cause and effect of technological advancements, which are increasing the skill gap. Furthermore, as the workforce ages in the automotive industry, it leads to a loss of valuable knowledge (Streb et al., 2008; Bernardes et al., 2022). On the other hand, the diverse nature of human resources in the automotive sector adds complexity because of the perspectives, work styles, and expectations (Amorim et al., 2022). In addition, the supply chain issues arose because of COVID-19, resulting in temporary layoffs or reassigning work to distinct roles in the automotive sector (Bradley, 2022).

This is why our review aims to present a comprehensive view of the emerging trends, current challenges (James et al., 2022), and strategies explored by researchers within the automotive industry related to workforce planning and human resource management (HRM) for the period from 2014 to 2024. We aim to provide answers to the research questions:

(1) Which countries are leading research related to workforce planning in the automotive industry?
(2) What are the most commonly explored themes and emerging topics?
(3) What are the dominant keywords and their co-occurrence patterns?
(4) How has the academic focus on strategic human resource management evolved in the context of the automotive sector over the past 10 years?

2. Literature Review

The objective of this literature review was to identify the research gap in HRM within the automotive industry. Overall, the topic has been intensively researched, influenced by the challenges as detailed in Introduction Section. Therefore, we structured the literature review into four subsections: organizational culture and HR-green practices; workplace and team structuring; leaders, managers, and supervisors; and new trends influencing HR for better insights, and comprehensiveness of the literature.

2.1. Organizational Culture and HR-Green Practices

Companies that incorporate sustainable practices (SP) are expected to deliver environmental, economic, and social benefits (Yadav et al., 2019). As shown by Yoo and Kim (2019), companies can solve the social or environmental issues in their work and create co-value (corporate, environmental, and social values) by implementing the Creating Shared Value (CSV) concept.

Evidence from Gedam et al. (2023) suggests that the companies in the automotive sector can foster information-sharing behavior if they focus on sustainable supply chain costs (end-to-end) with the aim of long-term sustainability. This is further supported by findings from (Gurzawska, 2020), where the cost-effective Supply Chain Management (SCM) is a pivotal ingredient for businesses' survival in increasing uncertainties coming from globalization.

The systematic literature reviews prior to Industry 4.0 have focused on workforce flexibility (Michalos et al., 2010) and generational context (Walmsley, 2007). Meanwhile, the manufacturing sector has witnessed a paradigm shift from a traditional supply chain to a modern supply chain under Industry 4.0 (Abdirad et al., 2021), requesting more flexible Supply Chain Management (SCM). Therefore, it requires an area for a more responsive HRM in hiring qualified engineers and managers, monitoring the needs for training and development of employees, and improving the system approach to motivate employees,

with particular emphasis on management style (Stawiarska et al., 2021). In addition, it is necessary for managers and decision-makers to develop the sustainable capabilities of their suppliers and involve them in the decision-making process, which will help the automobile sector (AS) improve its sustainability performance (Gedam et al., 2021). As claimed by Choudhary et al. (2020), green HRM and green performance are incomplete without considering their processes. If employees are informed about the benefits of adopting green practices and their impact, they are more likely to be environmentally friendly within the organization. More importantly, they will voluntarily engage in the company's green activities. For instance, green human resource management (GHRM) practices can positively influence the environmentally friendly behaviors of employees and boost the environmental productivity programs of organizations (Darvishmotevali & Altinay, 2022), but achieving this requires the development of technical and analytical skills (hard skills) (Choudhary et al., 2020).

2.2. Workplace and Team Structuring

A gap revealed by Avey and Holley (2024) opens the discussion on how employees want meetings and schedules to be managed and how they are handled. As such, bridging this gap requires designing smarter and more inclusive scheduling systems and workflows that account for individual differences and organizational contexts.

Organizations should empower leaders and managers to deeply understand teams, practice frequent and meaningful recognition, and emphasize positive engagement as a continuous process rather than solely focusing on outcomes. These practices build a stronger sense of connection, trust, and belonging in a remote work environment (Avey & Holley, 2024).

A combination of implementing employees' HFE awareness, transformational HFE leadership, and adequate levels of self-efficacy can yield positive outcomes if educating employees about the principles of ergonomics, such as proper workstation setup, can help them optimize their home work environments. In addition, the WFH can be significantly enhanced if the selected leaders inspire and guide employees in adopting ergonomic best practices. On the other hand, employees' belief in their ability to successfully set up and manage their WFH environment positively influences outcomes like productivity and satisfaction (Lee et al., 2024).

Managers play an important role in ensuring that the evaluation of digital tools and practices creates equal opportunities for employees to participate by ensuring equity and inclusion in the modern technology-driven workplace (Pekkala, 2024). Different models are built to optimize team structuring. For instance, the Graph Combinational Optimization DQN framework designed by Lv et al. (2024) addresses the complex employee replacement and organizational restructuring challenge by applying a model that includes employee data such as skills and attributes, and optimizes the team formations while taking into consideration the limited resources of the organization. Similarly, a model that helps match workers to tasks based on their individual skills while also considering how well they interact and collaborate with one another, thereby ensuring better team dynamics, was proposed by Maheut et al. (2024).

HRM strategies must be adapted to the size and context of the organization. Medium-sized enterprises can tailor their HR strategies by considering their specific resources and challenges. Smaller organizations can prioritize fostering interpersonal relationships and understanding the unique dynamics of their workforce (Juchnowicz et al., 2024).

Overall, managers should assess their teams' work environments and individual psychological traits to determine the most effective leadership approach. By adopting an inclusive leadership style, managers can improve employee autonomy, job satisfaction,

and overall remote work performance, while also addressing challenges such as work–life balance (Ding et al., 2024).

2.3. Leaders/Managers/Supervisors

The senior managers must align rewards and training and consider how individual perceptions and interpersonal dynamics affect the adoption of changes, as they can hinder the implementation of new practices in the organization, as emphasized by Feylessoufi et al. (2024). This can be achieved by integrating HRD (Harney & Gubbins, 2024) (focused on employee learning and development) and HRM (focused on employee management and organizational needs). The skill-based agenda is where employees' capabilities are developed by encouraging shared learning and teamwork across different roles and disciplines, while prioritizing interpersonal relationships and communication in people management to improve engagement and effectiveness.

Furthermore, Di Prima et al. (2024) conducted a survey on 281 HR managers from Europe, and the results highlight a positive relationship between organizational creativity, employee training, organizational knowledge sharing, recruitment, and selection. Meanwhile, human resource analytics positively moderates these relationships.

On the other hand, the involvement of balanced hierarchical dynamics and resource allocation is often influenced by biases, lack of information, time pressure, organizational politics, and resistance from team members at various levels, as shown by Jena (2024), Thus, the managers must have adequate time, staff, and tools to execute decisions effectively.

The skills, knowledge, and expertise of employees can offer flexibility and reduce the reliance on suppliers by contributing more effectively to innovation and problem-solving through a highly educated workforce, supported by experienced leadership with technical knowledge that can guide the firm through challenges and embrace innovation (Lin & Deng, 2024).

2.4. The Influence of New Trends on HR

Organizations that take into consideration the factors of fair compensation, growth opportunities, work–life balance, and alignment with company values are more likely to attract and retain top talent, which leads to higher job satisfaction and long-term success (Sierdovski et al., 2024). In addition, careful reviews must be conducted for employee perceptions and well-being profiles to identify misalignments between organizational strategies and employee experiences. Addressing these inconsistencies can result in improved employee satisfaction, enhanced engagement, and more effective talent retention strategies (Molnár et al., 2024).

Furthermore, as organizations increase their focus on improving Employee Experience (EX), they must consider multiple factors, including well-being engagement, and organizational culture. This comprehensive approach to Employee Experience (EX) leads to better job satisfaction, improved employee retention, and ultimately greater organizational success (Molnár et al., 2024; Reina et al., 2024). As supported by (Berber & Gašić, 2024), integrating employee feedback and cultural considerations into compensation strategies will help ensure that employees stay engaged, satisfied, and loyal to the organization.

The ability of generative AI (artificial intelligence) to support employees in more creative or meaningful tasks leads managers to argue the potential it has in enhancing job fulfillment for employees (Roberts & Candi, 2024).

Despite the known benefits of well-being and positive impacts on the organizations' overall performance and competitive advantage, there remains a lack of understanding of how employee well-being is incorporated into HRM strategies and practices (Molnár et al., 2024). Age management for organizations globally, as the workforce ages and requires

different approaches to maintaining productivity and well-being, is another perspective to consider in HR strategies and practices (Macassa et al., 2024).

The potential of AI (artificial intelligence) in using data in the selection and hiring process: candidates' roles, previous experiences, and learning styles can create a customized onboarding plan. AI-powered systems can adjust the content and pace based on individual progress, ensuring that new employees do not feel overwhelmed by the information (Brown, 2024). For optimal adoption of these strategies, it is important to integrate HRM, IoT, technology, and other key elements to enhance organizational operations.

While challenges such as resistance to change, skill gaps, and integration issues exist, implementing best practices such as regular performance evaluations, robust security measures, and personalized customer experiences can mitigate these obstacles. In this way, organizations can not only enhance productivity and competitiveness but also build a sustainable model for future growth and success (Sun & Jung, 2024). Furthermore, the availability of big data allows HR managers to make more informed decisions and data-driven strategies for hiring, promotions, training, and other talent management practices (Annisa & Siahaan, 2024).

In summary, the literature review focuses on the long-term HR impact of driven by uncertainties and rising challenges in the automotive sector. The gap that was identified is summarized in the following question: *"What are the key strategies, challenges, and trends in workforce planning and up skilling within the automotive industry, and how do they impact employee wellness and organizational performance?"*

3. Materials and Methods

Study design and search strategy: For our research design, we applied a mixed-methods approach using qualitative and quantitative analysis of bibliographic data. Bibliometric analysis was performed to map the research topic. Furthermore, we used the Systematic Literature Review (SLR) method to provide further clarification and insights (Dewey & Drahota, 2016) for the questions identified in the Literature Review section. We started our study on 20 July 2024. The bibliographic data were selected from the Scopus database (https://www.scopus.com/home.uri; study commencement date: 20 July 2024). We chose the Scopus database because 99.11% of the journals indexed in Web of Science are also indexed in Scopus, as well as 96.42% of Scopus-indexed journals are found in Dimensions (Singh et al., 2021). Furthermore, Singh et al. (2021) suggest that the Web of Science is the most selective; meanwhile, Dimension includes a broader range of sources, making it challenging to navigate the topic. Scopus provides metrics for citations and h-index, and offers high-quality, peer-reviewed academic journals (Donthu et al., 2021), making it suitable for our review since we used R Studio's bibliometrix package (Aria & Cuccurullo, 2017) to gain a comprehensive understanding of the automotive industry.

The search query consisted of the following keywords: "automotive industry", "workforce planning", "strategic human resources", "employee wellness", "workforce forecasting", "upskilling", "human resources" (last accessed and revised: 19 January 2025, as we included additional papers published through the end of 2024, ensuring the inclusion of research for the year 2024). Further details about the search process can be found in Table A1 of Appendix A. Moreover, the keywords were not selected randomly but based on our comprehensive literature review section, where we identified the areas of focus for the automotive industry related to workforce planning and the strategic management of human resources. We applied the PRISMA protocol to record the included and excluded papers (Page et al., 2021), as presented in Figure 1.

Exclusion criteria: We identified a total of 955 documents from the Scopus database based on our search query. In the identification stage, we excluded 398 papers published

before 2014. Furthermore, 267 papers in the subject areas of engineering, computer science, environmental science, energy, medicine, art and humanities, mathematics, material science, earth and planetary sciences, chemical engineering, biochemistry, genetics, and molecular biology, agricultural and biological sciences, and neuroscience were excluded (see Appendix A). Furthermore, in the screening stage, we ended up with 291 papers, from which we excluded 4 review papers, 4 conference reviews, 71 conference papers, 4 books, and 17 book chapters because we were interested in comprehensively reviewing the empirical studies on the topic. Moreover, we excluded a total of 13 papers in Chinese, Spanish, Portuguese, Slovak, Romanian, Moldovan, German, and Persian; this is further displayed in Figure 1, as we were interested in evaluating the English literature.

Paper included: During the inclusion stage we included papers published from 2014 to 2024, and we limited the subject area to business, management, accounting, social sciences, decision sciences, economics, econometrics, and finance, and psychology because of their relevance to our research topic related to organizational behavior, decision-making processes, and HR practices. In total, we included 180 articles in our review, with an annual growth rate of 10.31%. The average age of the documents was 4.92, and the average citations per article were 16.93. Further information is found in Appendix A for the PRISMA protocol applied in this review during the search process and the identification, screening, and inclusion stages of the PRISMA protocol. Furthermore, the geographical distribution of the papers was as follows: Asia with 34.2%, Europe with 33.8%, North America with 9.5%, South America with 3.5%, Africa with 7.8%, Oceania with 2.2%, and the Middle East with 9.0% (more detailed information is provided in the Supplementary Materials).

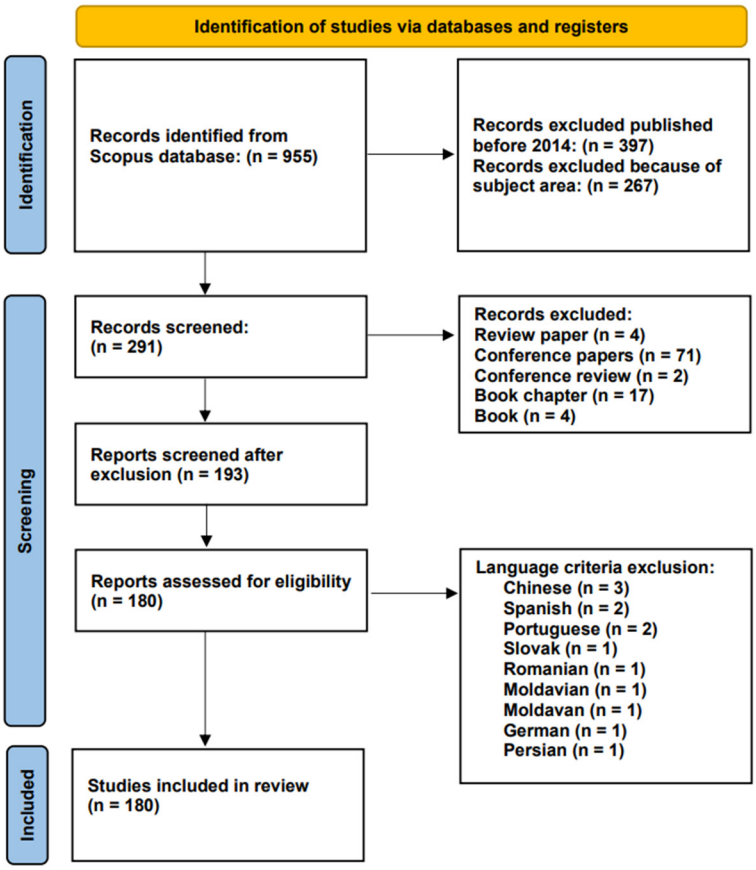

Figure 1. PRISMA Flow Chart Source: Authors' work based on Page et al. (2021).

4. Results

To answer research questions, we have divided the results into two parts: Scientific Production (Section 4.1) and Themes and Emerging Topics (Section 4.2).

4.1. Scientific Production

Figure 2 illustrates the number of articles published annually from the year 2014 to 2024. The *x*-axis represents the years, while the *y*-axis shows the number of articles produced annually during these years, with a value ranging from 10 to 30. The red line represents the progression of the scientific work over the respective years, meanwhile the blue dots show the number of articles with the corresponding year. The figure indicates that the highest number of articles was published in 2022, with 31 articles, and the lowest number was in 2015, with 7 articles. Over these years, there have been clear fluctuations of increases and decreases, but with an overall upward trend, which suggests a growing interest in the research topic. We can see a significant increase in publications after 2020, peaking in 2022. Meanwhile, 2023 saw a slight decline in comparison with 2022. Fluctuations in various years can be influenced by external factors, such as COVID-19 in 2020.

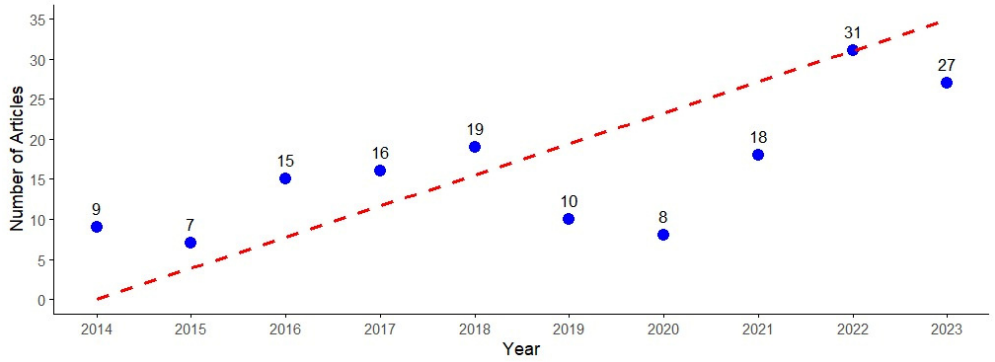

Figure 2. Annual Scientific Production (2014–2024). Source: Authors' work.

Furthermore, Figure 3 illustrates the number of articles published by countries from the year 2014 to 2024. The graph suggests that India, Iran, Italy, Malaysia, and the United Kingdom dominate scholarly work. In addition, India shows a steady increase from 2014 to 2020, followed by significant increases from 2020 to 2024, which correlates with the post-COVID-19 period. Similar patterns are evident in Iran, Italy, Malaysia, and the United Kingdom.

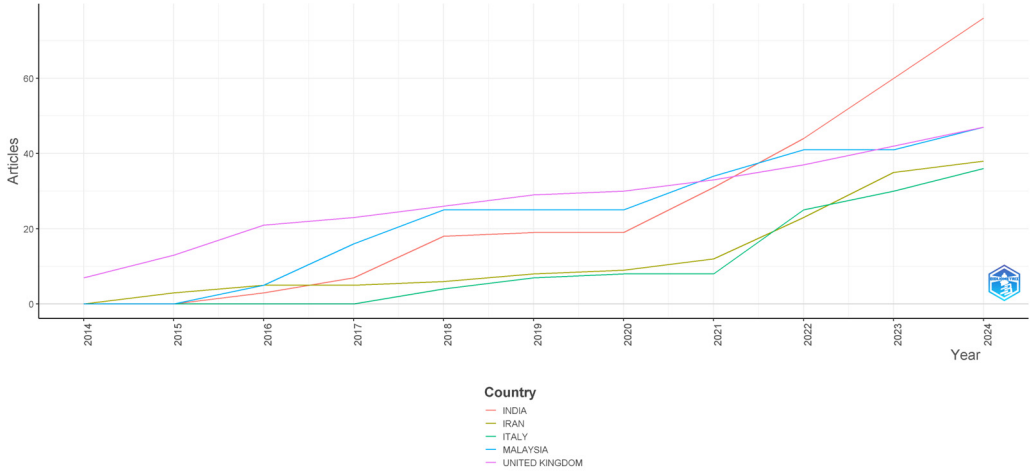

Figure 3. Scientific Production by Country (2014–2024). Source: Authors' work.

In Table 1, the journals, their scope, total production (TP), H-index, SJR, SJR quartile, country, and corresponding publisher are displayed. The journals with the highest total production of scholarly work are the International Journal of Automotive Technology and Management, the International Journal of Production Research, and the SA Journal of Human Resource Management, with seven, six, and five articles, respectively, as shown in Table 1. According to the journals' scopes, they focus on trends and innovations in the areas of automotive technology, human resources, sustainability, education, business strategy, and quality management. This is further confirmed by the second part of the results, Section 4.2 Themes and emerging topics.

Table 1. Most relevant journals (2014–2024) and compiled from Information found in Scimago Journal and Country Ranking (SJR: https://www.scimagojr.com/, accessed on 26 February 2025), TP (total production). Source: Authors' work.

Name of Journal	Scope	TP	H-Index	SJR	SJR Quartile	Country	Publisher
International Journal of Automotive Technology and Management	Industrial organization; business management.	7	27	0.4	Q2	United Kindom	Indersciences Enterprises Ltd.
International Journal of Production Research	Innovation management; design of products; manufacturing processes; production and logistics systems.	6	186	2.67	Q1	United Kindom	Taylor and Francis Ltd.
SA Journal of Human Resource Management	Improvement of people management throughout business-relationship structures (policies and systems).	5	15	0.3	Q2	South Africa	AOSIS (Pty) Ltd.
International Journal of Production Economics	The interface between engineering and management.	4	231	3.07	Q1	Netherlands	Elsevier B.V.
Journal of Cleaner Production	Increasing efficiencies in the use of energy, water, resources, and human capital.	4	309	2.06	Q1	United Kindom	Elsevier Ltd.
Journal of Engineering Education Transformations	Engineering education; students.	4	11	0.19	Q4	India	Rajarambapu Institute of Technology
Management Decision	Entrepreneurship and Social Enterprise, Corporate Social Responsibility and Sustainability, etc.	4	126	1.14	Q1	United Kindom	Emerald Group Publishing Ltd.
TQM Journal	The theoretical development and the practical application of both the "hard" and "soft" aspects of TQM.	4	79	0.94	Q1	United Kindom	Emerald Group Publishing Ltd.
International Journal of Human Resource Management	People Management.	3	139	2.08	Q1	United Kindom	Routledge
Journal of Technical Education and Training	TVET Issues and concerns.	3	14	0.23	Q3	Malaysia	Penerebit UTHM

Table 2 demonstrates the evaluated global cited papers on the topic related to their relevance, methodology, validity and reliability, and overall quality. The papers by Govindan et al. (2016), Leal-Millán et al. (2016), and Martín-Peña et al. (2014) are more related to logistics, environmental policies, and supply chains compared to Chiappetta Jabbour et al. (2017), Lacerda et al. (2016), Popaitoon and Siengthai (2014), Kumar et al. (2019), Jerman et al. (2020), Krzywdzinski (2017), and Gonzalez and de Melo (2018). Additional details can be accessed in the Supplementary Materials.

Table 2. Evaluation of the most globally cited papers (2014–2024). Source: Authors' work.

Authors	Relevance	Methodology	Validity and Reliability	Contribution	Overall Quality
Govindan et al. (2016)	Effective 3-PL selection in developing countries	Gray Dematel Method	Highly reliable with structured methodology.	Advances in 3-PL research in SCM and decision-making method.	Novel methodological approach.
Chiappetta Jabbour et al. (2017)	Integration of GSCM and GHRM	Resource-Based Theory to analyze the connection between Critical Success Factors and GSCM adoption.	Case study on three focal companies.	Links green HR practices to more effective supply chain strategies.	Strong theoretical base and practical implementations.
Lacerda et al. (2016)	Lean Manufacturing and process improvement	Case study using Value Stream Mapping	A real-world application in a company and production process.	Demonstrates the practical application of VSM in lean manufacturing, proving improvements in cycle time, workforce efficiency, and cost efficiency. Highlights the importance of Kaizen meetings.	Case study with clear methodology and measurable outcomes.
Popaitoon and Siengthai (2014)	HRM Project Management and Knowledge Management	Survey-based study; sample size: 198 projects in multinational companies; Investigates the moderating effects of HRM practices on knowledge absorptive capacity and project performance	Quantitative approach and structured analysis	Expands HRM literature in Project Management. Highlights the short-term and long-term success of HRM on project success.	Clear theoretical grounding and provide empirical support.
Kumar et al. (2019)	GSCM practices focusing on soft (human-related) dimensions of sustainability	Best-Worst Method; DEMATEL (decision making trial and evaluation laboratory) method	Structured approach and decision-making techniques	Emphasizes soft dimensions: management commitment, employee involvement, organizational culture, and teamwork.	Practical implications for industry managers

Table 2. *Cont.*

Authors	Relevance	Methodology	Validity and Reliability	Contribution	Overall Quality
Jerman et al. (2020)	Smart manufacturing, Industry 4.0, and HRM.	Qualitative research using case study analysis; semi-structured interviews; and content analysis	Systematic approach; Diverse sample size of experts from governmental, educational, and private sectors.	Highlights the impact of smart factory systems on employee competencies and job profiles in the automotive industry.	Practical insights into HRM in smart factories.
Leal-Millán et al. (2016)	Customer capital, IT capability, relationship learning, green innovation performance on strategic management, and supply chain dynamics.	Partial-least squares regression analysis; data sample: 140 Spanish automotive component manufacturers	Structured quantitative analysis and well-defined causal relationships.	Links IT capability, relationship learning, and green innovation performance to customer capital. Emphasizes the green innovation performance mediation role.	Theoretical ground and empirical support. Limitation: Capturing the long-term effects.
Martín-Peña et al. (2014)	The trade-offs of Environmental Management Systems adoption.	Factor Analysis; Sample size: 228 supplier and manufacturer firms.	Large dataset and structured quantitative analysis.	Highlights key EMS benefits: market position, stakeholder relations, environmental performance, and access to green technologies. EMS challenges: organizational structure, human resource commitment, and environmental information management.	Practical insights for firms considering EMS adoption.
Krzywdzinski (2017)	Manufacturing, automation, and labor dynamics.	Comparative approach Sample: employees are a quantitative survey and qualitative case studies.	Quantitative insights from employee representatives and qualitative case studies from companies.	Finds that employee representatives have less influence than expected, questioning the worker power in the Industry 4.0.	Challenges the notion that automation alone shapes labor-use strategies.
Gonzalez and de Melo (2018)	Organizational knowledge and strategic management.	Cluster analysis using clustering: innovative, exploitative, and passive companies. Sample size: 234 automotive companies.	Large sample size and clearly defined variables.	Identifies how five (5) contextual factors: HRM, supportive leadership, learning culture, autonomy, and IT systems impact knowledge exploration and exploitation.	Introduces a new typology of firms based on knowledge management and innovation strategies.

4.2. Themes and Emerging Topics

Figure 4 represents the keywords and the topics, where the size of each word indicates its importance and the frequency with which scholars use them. Meanwhile, Figure 5 shows the density of the keywords, where the intense color represents the greatest focus of scholarly work. Both Figures 4 and 5 display that "human resource management" is the largest word, followed by the keywords "Industry 4.0" and "decision making". This is because human resource management can be influenced by Industry 4.0 and can also influence decision-making. Where the coordination of "employment", "engineering

education", "knowledge management", "project management", "personnel", innovation", "skilled labor", "labor market", "job satisfaction", etc., is essential for the functioning of the center of the automotive industry, as displayed by the keywords "supply chain management", "supply chains", "manufacture", "competition", "smart manufacturing", "commerce". Figure 5 shows in detail the interconnection between these keywords.

Figure 4. Word Cloud. Source: Authors' work.

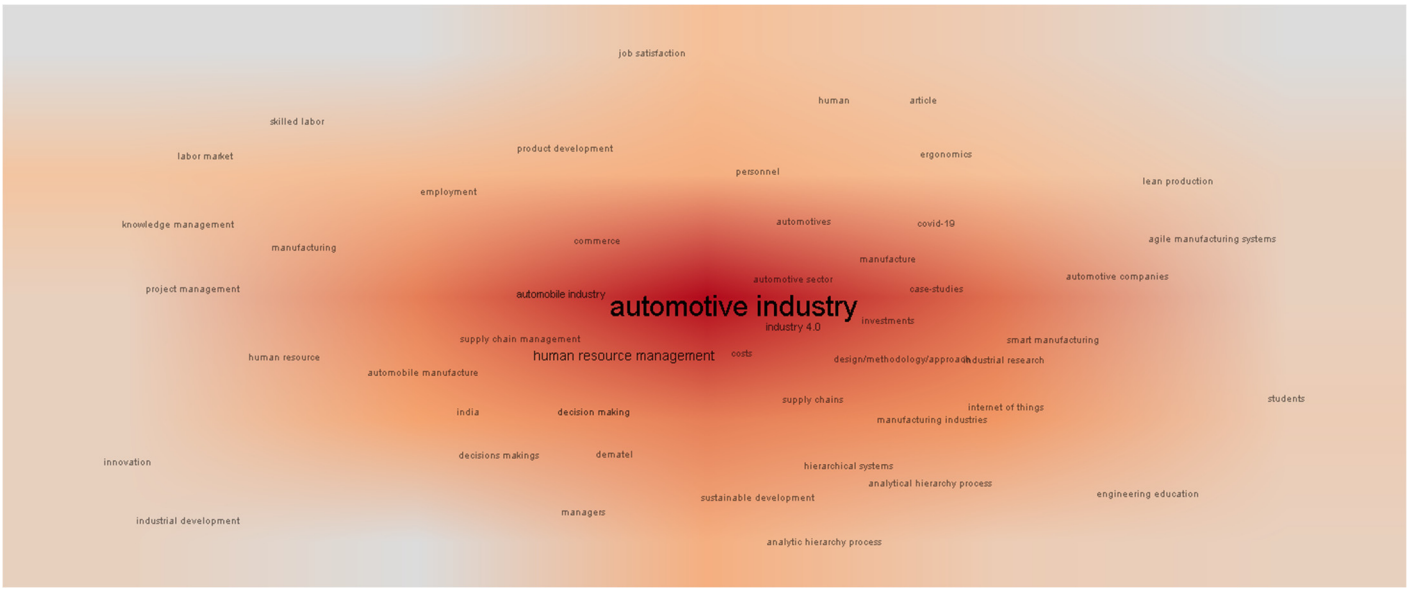

Figure 5. Density of Keywords. Source: Authors' work.

The co-occurrence network of keywords visually displays the relationship between the concepts and keywords based on how often they appear in the figure. Figure 6 shows the results of the analysis we conducted, revealing 10 clusters that illustrate the relationship between the keywords.

- The blue cluster is the largest cluster, with the main keyword "automotive industry" representing the main focus area. The cluster depicts that this cluster acts as the anchor to which all other keywords are linked to each other. This group includes keywords such as "Industry 4.0", "product development", "internet of things", "case studies", "personnel", "manufacturing industries", "investment", "COVID-19", "smart manufacturing", "design/methodology/approach", costs" showing the focus of scholars on technological advancements and challenges arising in the field of the automotive industry.

- The green cluster visualizes keywords such as "dematel", "managers", decision making", "india", "automobile manufactures", highlighting the focus on managerial decision-making in the automotive industry in emerging markets like India.
- The red cluster depicts the keywords "human resource", "automobile industry", "employment", showing the scholars' focus on human resource management on this topic.
- The orange cluster indicates keywords such as "lean production", "agile manufacturing systems", and "automotive companies". This cluster reflects research that utilizes practical approaches to explore the outcomes and applications of agile practices and lean production in the manufacturing stage.
- The brown cluster provides insights on "manufacturing", "labor market", and "skilled labor", exploring the labor market needs and skills necessary associated with manufacturing the keywords in the blue cluster.
- The purple cluster with the keywords "human", "ergonomics", "article", "industrial research", "manufacturing", and "job satisfaction" explains the research needed to understand the human context of manufacturing and topics related to employee satisfaction, which are connected to job satisfaction.
- The pink cluster visualizes the "analytical hierarchy process", "hierarchical systems", and "sustainable development", which are linked with the decision-making process, evaluation, sustainability management, and project management.
- The light green, gray, and beige clusters, despite being the smallest among all the clusters, show the important connection between "knowledge management" and "project management". Meanwhile, the gray cluster visualizes the critical role of "students" and "engineering education". The intersection between "innovation" and "industrial development" is illustrated in the beige cluster.

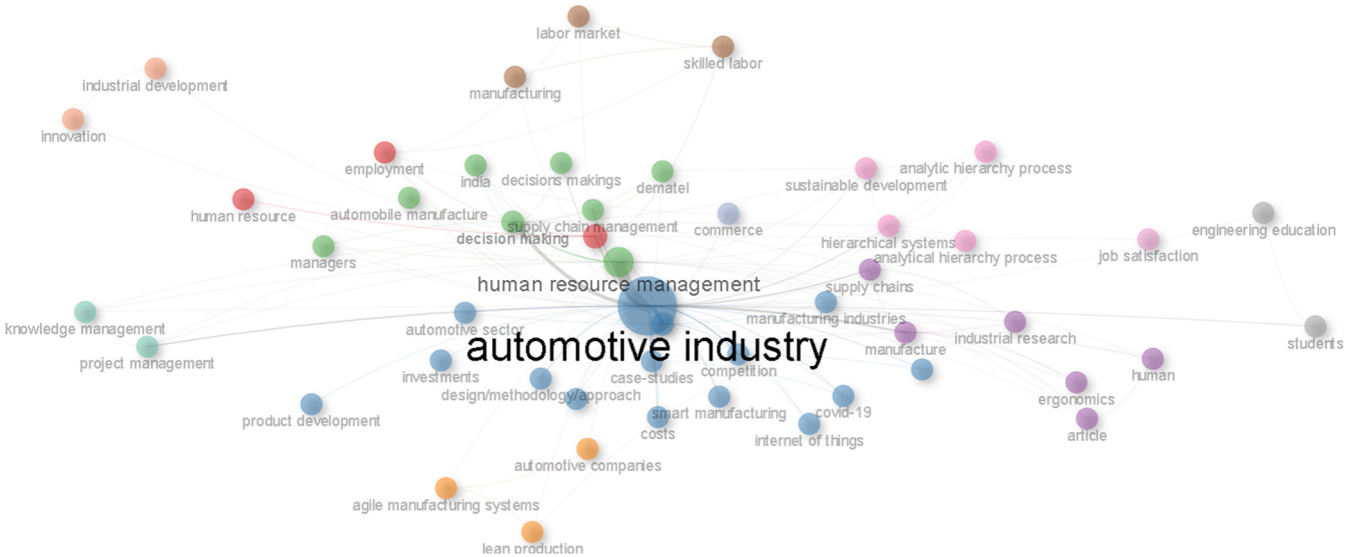

Figure 6. The Co-occurrence of Keywords. Source: Authors' work.

Figure 7 depicts the trend topics between 2016 and 2024. The circles indicate how often the topic was studied, with the larger circles representing more frequent studies and smaller circles representing less frequent ones.

From 2014 to 2016, scholars showed interest in the topic "leadership", emphasizing the need for transformational leadership, digital leadership, and leadership in crisis management which is further supported by the trends over the years with keywords like "innovations", "knowledge management", "skills", and "COVID-19". During the period from 2017 to 2022, "knowledge management" also emerged as a specific trend, highlighting the integration of knowledge sharing in Industry 4.0. In the years 2017 to 2019, scholars paid

attention to "innovation" due to technological advancement, reaching a peak of research in 2018 because of AI, IoT, blockchain, and startup ecosystem developments. Between the years 2019 and 2024, topics like "skills" began to gain traction, highlighting the importance of digital upskilling needs influenced by Industry 4.0, technological advancements, and the COVID-19 pandemic. As presented in Figure 6, in the year 2023, researchers showed interest in the "COVID-19" topic from 2022 to 2024, exploring the pandemic's impact on remote work, business workforce, resilience strategies, and education.

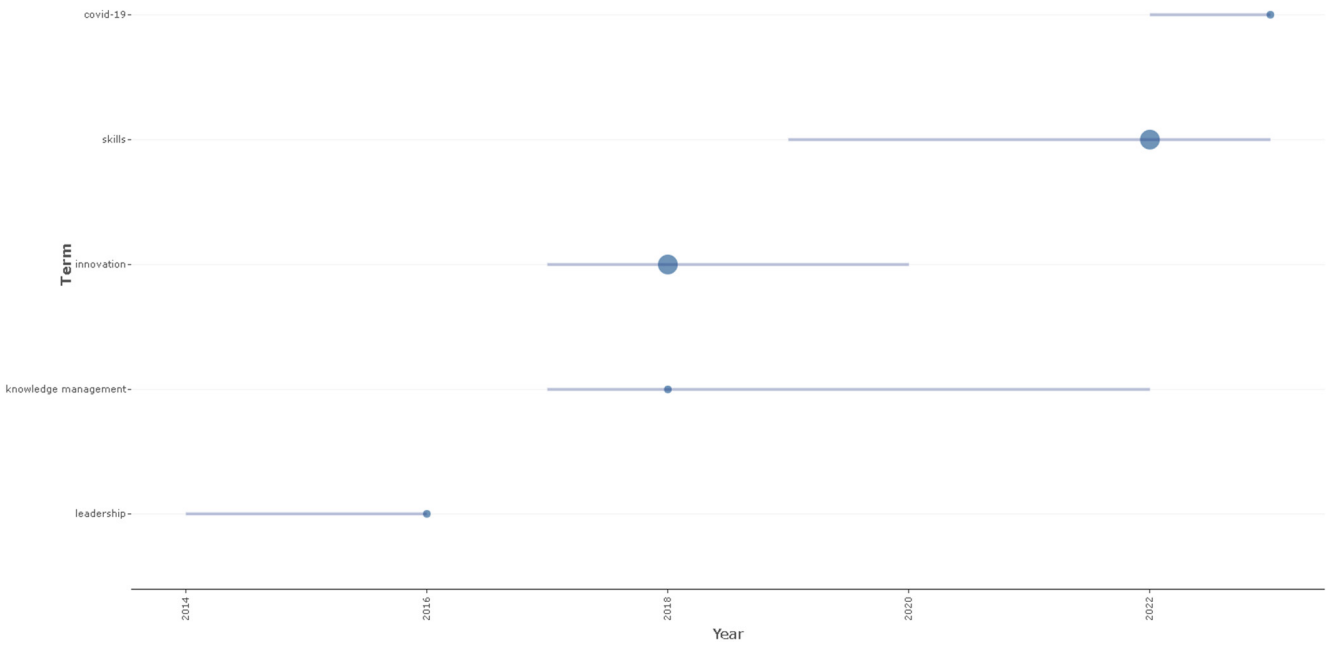

Figure 7. The Trend Topics. Source: Authors' work.

Figure 8 visualizes the thematic topics in four divisions: motor themes, basic themes, emerging/declining themes, and niche themes. The *x*-axis shows the relevant degree of the clusters, while the *y*-axis displays the development degree of the clusters. Motor themes represent the principal topics; basic themes are the transversal themes, emerging/declining themes are at the crossroads, and niche themes are the isolated but well-developed themes. The size of the cluster reflects the intensity and density of scholarly work on the topics.

Motor theme clusters are "ergonomics, article, human" and "automotive industry, human resource management, Industry 4.0". Topics related to the automotive industry, HRM, and Industry 4.0 are the principal subjects and drivers for scholarly work. Meanwhile, the topic of ergonomics has shown a degree of development and relevance due to human-centered research, often connected to workplace safety, productivity, and well-being. On the other hand, the cluster "automobile industry, commerce, employment" is highly relevant and well developed because of HR's interest in the direct employment impact on sales, marketing, and commerce resulting from global supply chains, market growth, and fluctuations, etc.

Basic themes have only one cluster: "costs, COVID-19, industrial research". Since COVID-19 was a transversal topic in the automotive industry, researchers are exploring the post-pandemic situation and the costs associated with operations, industry, and related HRM. The cluster "internet of things, application programs, digital storage", which has high relevance and ongoing development, presents the drivers of digital transformation in the automotive industry. This cluster is important because it shapes the HR strategies and practices, requiring more flexibility and adaptability from the labor market.

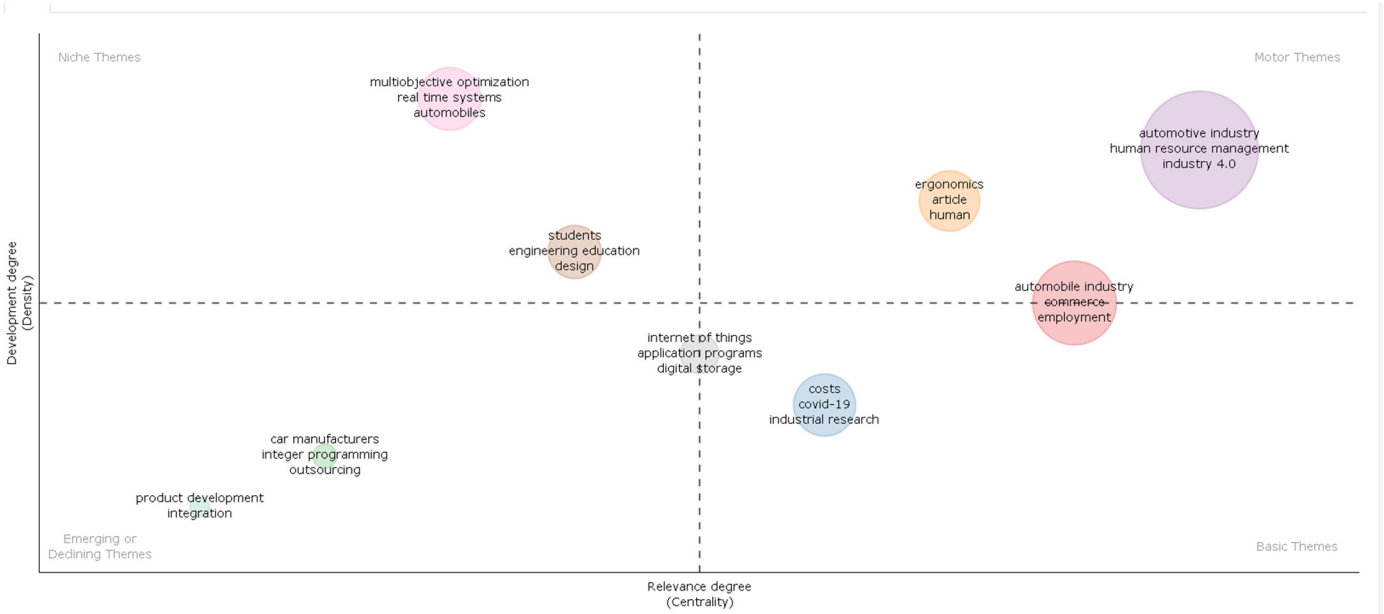

Figure 8. The Thematic Topics. Source: Authors' work.

Emerging or declining themes are clusters of "product development, integration," and "car manufacturing, integer programming, outsourcing". Car manufacturing, integer programming, and outsourcing are connected to the optimization approach toward production efficiency, labor costs, and sustainability. Meanwhile, product development and integration are closely related to ensuring the right skills for future innovations, upskilling or reskilling, and fostering creativity and organizational culture.

Niche themes are the clusters "students, engineering education, design", and "multi-objective optimization, real-time systems, automobiles". Autonomous driving, electric vehicles, and smart manufacturing influence the design, engineering education, and the upskilling or reskilling of students and are connected to multi-objective optimization (MOO).

5. Discussion

The answer to question 1: "Which countries are leading the research related to workforce planning in the automotive industry?" The countries with the highest scientific production on the topic are India, Iran, and Italy, as displayed in Figure 3. The growing interest of India in the automotive sector (Mohsen et al., 2021), as well as the good market position of Italy in luxury brands (Caruso, 2024; Baciarlini, 2021), prompts these countries to explore the opportunities of human resource strategies to expand their market share in the automotive industry. As displayed in Table 1, the International Journal of Automotive Technology and Management, the International Journal of Production Research, and the SA Journal of Human Resource Management have the highest scientific production. Meanwhile, the research conducted in workforce planning and HRM within the automotive industry has experienced fluctuations over the years, but with an overall increasing trend (see Figure 2).

The answer questions 2, 3, and 4 related to the emerging topics, bibliometric patterns, and the SHRM evolution in the automotive sector: Figures 4 and 5 present the main influences and drivers for the HRM transformation and decision-making related to Industry 4.0, SCM, and supply chains, manufacturing, and smart manufacturing. As shown in Figure 7, "COVID-19" appears as a trending topic from 2022 to 2024, as questions remain about the post-effects of the pandemic in upstream and downstream supply chains (Dienes et al., 2024), as well as the potential tools to manage labor dynamics and the skills gap (Sakka et al., 2022) to ensure

resilience under uncertainties. Moreover, implementing employee engagement programs can improve overall productivity, motivation, and job satisfaction, while simultaneously ensuring employee retention (Sundarrajan & Krishnan, 2024; Venkat et al., 2023). The interconnections between HRM practices and Industry 4.0 require more research on human factors and ergonomics, as supported by Kadir et al. (2019). The "human, ergonomics, and industrial research" are new principles that have been well developed (Figure 7) because firms have been focusing on ongoing training programs in industrial automation of several manufacturing processes, EVs, AI (Bathla et al., 2022), and tech-focused talent acquisitions (Shufutinsky et al., 2020). As discussed by researchers before the fourth industry revolution (Industry 4.0), there was an emerging need for a more flexible and adaptive approach by establishing remote and flexible schedules (Michalos et al., 2010; Drahokoupil et al., 2015) and ergonomic workplaces (Thun et al., 2011; Neubert et al., 2012).

Furthermore, knowledge management became a trend during the period 2017–2022 (Figures 6 and 7) because knowledge retention and sharing became important after the post-COVID-19 era. The model shift from traditional to remote/hybrid work styles (Drahokoupil et al., 2015) became important for project management in the automotive sector to ensure physical and mental well-being (Bunescu et al., 2024).

"Students and engineering education" (Figure 7) appeared to be a niche theme with high relevance in knowledge retention and sharing, as well as reskilling/upskilling of the workforce during uncertainties (COVID-19, technological disruptions). At the same time, the need for the implementation of HR policies (Kess-Momoh et al., 2024) and leadership development programs for managers (soft skill development) (Schulz, 2024; Loumpourdi, 2024), grew. This is further supported by the trend of "skills" (Figures 5 and 6) for the period 2019–2024, showing the importance of reskilling and upskilling (Costa et al., 2024) related to digital upskilling and knowledge-sharing systems through online training tools (Tafakur et al., 2023; Thangavelu & Kanagasabapathi, 2019).

Theoretical implications: Our review findings indicate sustained developments in the literature on strategic human resources, workforce planning and forecasting, employee wellness, reskilling, and upskilling, with a major focus on ergonomic workforce and flexible work models. Furthermore, the challenges are synergized with HR practices to achieve organizational goals, predict future labor needs, and ensure agility during industrial changes. It also highlights the importance of employee health, satisfaction, and productivity, as well as skill development for employees, leaders, and managers. Our research reveals that employee wellness, reskilling, and upskilling mainly impact the operational level of the organization. This is further synthesized in Table 3 as a practical implication.

Table 3. Practical Implementation of HR Strategies in the Automotive Industry. Source: Authors' work based on literature review.

Thematic Area	Impact	Challenges	HR Strategy
Strategic human resources	Strategic Level	Alignment of HR practices with organizational goals.	HR policies to support fast-paced technological shift (Kess-Momoh et al., 2024). Tech-focused talent acquisitions (Shufutinsky et al., 2020). Employee engagement programs (Sundarrajan & Krishnan, 2024; Venkat et al., 2023).

Table 3. *Cont.*

Thematic Area	Impact	Challenges	HR Strategy
Workforce planning and forecasting	Tactical level	Future labor needs prediction and adaptation to industry changes.	Flexible work models (Drahokoupil et al., 2015). AI- tools to predict labor shortages and skill gaps (Sakka et al., 2022).
Employee Wellness	Operational level	The employee health, satisfaction, and productivity enhancement.	Implementation of remote and flexible schedules (Michalos et al., 2010). Ergonomic workplaces (Neubert et al., 2012; Thun et al., 2011). Stress Management programs to ensure physical and mental well-being (Bunescu et al., 2024).
Reskilling/upskilling	Strategic/Tactical/ Operational level	New skills for employees, leaders, and managers' growth to meet emerging technological and operational demands in the automotive industry.	Ongoing training programs in emerging technologies related to EVs, AI, and automation (Bathla et al., 2022). Leadership development programs for managers/soft development skills (Schulz, 2024; Loumpourdi, 2024). Online training tools for personal growth through learning (Tafakur et al., 2023; Thangavelu & Kanagasabapathi, 2019)

6. Conclusions

Our findings show that the trending topics are skills, knowledge management, leadership, and COVID-19 for the period of 2014–2024. Furthermore, the research trends have influenced the emerging HR topics focusing on reskilling/upskilling and employee wellness in connection with mental and physical well-being. Meanwhile, ergonomics and human factors are the core themes for workforce planning. According to our literature, organizations have been impacted by employee wellness, reskilling, and upskilling at the operational level. We conclude that there is a gap in exploring the opportunities of the automotive industry in growing markets. There is a need for a comparison of the automotive industries in different countries. We identified a gap in systematic literature reviews addressing the human factor in the automotive sector (pre- and post-Industry 4.0). Moreover, our review provides theoretical and practical insights derived from the comprehensive review, which is aligned with the challenges and corresponding HR strategies (period 2014–2024).

Limitations: Our review is limited to the Scopus database, and further insights can be drawn from other databases. Furthermore, we analyzed the papers from 2014 to 2024. There is a lack of existing literature on other regions, as the majority of the papers are mainly from Asian, European, and North American researchers.

Supplementary Materials: Supplementary Materials can be accessed at the following link: https://drive.google.com/drive/u/0/folders/17WLgvaGwWgiT0uW8S5klDG96lpfGMVUU (accessed on 26 February 2025). For additional information, please contact the first author of the paper.

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Abbreviations

The following abbreviations are used in this manuscript:

HRD	Human Resource Development
HRM	Human Resource Management
EX	Employee Experience
AI	Artificial Intelligence
TVET	Technical and Vocational Education and Training
3PL	Third-Party logistics
GHRM	Global Human Resource Management
GSCM	Global Supply Chain Management
VSM	Value Stream Mapping
MOO	Multi-Objective Optimization
CC	Customer Capital
IT	Information Technology
RL	Relationship Learning
GIP	Green Innovation Performance
IoTs	Internet of Things
SCM	Supply Chain Management
HR	Human Resource
SP	Sustainable Practices
CSV	Creating Shared Value
AS	Automobile Sector
HFE	Human Factors and Ergonomics
WFH	Work From Home
EU	European Union
USA	United States of America

Appendix A

Table A1 presents the search process using the PRISMA protocol applied for this review in regard to the search keywords, period taken into consideration, subject area, document type, and language criteria.

Table A1. The search process uses the PRISMA protocol.

PRISMA Protocol	Search Process
Search Keywords	TITLE-ABS-KEY (“Automotive Industry”) AND TITLE-ABS-KEY (“workforce planning”) OR TITLE-ABS-KEY (“strategic human resources”) OR TITLE-ABS-KEY (“skills”) OR TITLE-ABS-KEY (“workforce”) OR TITLE-ABS-KEY (“Employee wellness”) OR TITLE-ABS-KEY (“Workforce forecasting”) OR TITLE-ABS-KEY (“upskilling”) OR TITLE-ABS-KEY (“Human Resources”)
Period included:	PUBYEAR>2013 AND PUBYEAR<2025
Subject area excluded:	Engineering, computer science, environmental science, energy, medicine, art and humanities, mathematics, material science, earth and planetary sciences, chemical engineering, biochemistry, genetics, molecular biology, agricultural and biological sciences, and neuroscience.
Document type included:	Articles
Language:	English

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