SURVEY

Discovering Trends and Journeys in Knowledge-Based Human Resource Management: Big Data Smart Literature Review Based on Machine Learning Approach

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ABSTRACT The research interest of knowledge in human resource management (HRM) is significant. Bibliometric or systematic literature review studies capture the main areas and trends in the field of HRM. However, many HRM studies work only with a limited number of analyzed documents (systematic literature review) or go more in breadth than in depth of researched topics (bibliometric reviews). This smart literature review study is based on processing metadata to get results from 7,318 documents related to human resource management and knowledge, published between 1960 and 2021, retrieved from the Scopus database with research directions linked to knowledge and human resources and the current topic Covid-19 pandemic. Such a broad study has not yet been published in the field of knowledge and HRM. The study answers three research questions related to trends and innovative journeys in knowledge-based HRM. Descriptive and inferential statistics was used to capture basic trends in knowledge and HRM themes. Latent Dirichlet Allocation (LDA) was used for topic modelling with Gibbs sampling, which we use on a corpus of abstracts. Used method allowed us to identify latent topics which describe a more in-depth relationship between HRM and knowledge. We identified 13 topics related to HRM and knowledge research as the most relevant and showed directions and trends among the authors of HRM and knowledge management. The last part is devoted to the current topic of Covid-19, key areas identified in the literature and their impact on knowledge management from the perspective of HRM. During the analyzed period, the highest increase of research interest and research impact was recorded by two topics - Employee performance and Risk management. Our study maps the development of these and other topics and more deeply characterizes research in knowledge-based HRM during the pandemic. The results thus offer an up-to-date scientific map of this rapidly developing field and can be the basis for a broader discussion on the future direction of HRM.

INDEX TERMS Machine learning, smart literature review, human resource management, knowledge, topic modelling, Covid-19.

I. INTRODUCTION

Currently, we can identify research areas with relatively dynamic development in management theory. One of them also includes the area of knowledge management linked to human resource management. Over the past decades, many

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studies with different focuses have been published in this area. Since these are thousands of studies, the comprehensive and in-depth review is no longer practically possible by manual means. Our study analyzes all related documents from the Scopus database covering 1960-2021. Its goal is to use machine learning algorithms to identify the main trends and journeys in knowledge-based human resource management. The study takes the form of a so-called smart literature

review – combining elements of bibliometric literature review with progressive text mining methods to identify and analyze unique topics appearing in monitored documents. In the introductory part of this section, the link between knowledge management and human resource management is explained, and three research questions are subsequently formulated. These are the basis for the choice of the processing procedure (section II Data and methodology), the presentation of the main results (section III Findings), and the presentation of implications and limitations (section IV Discussion).

As organizations seek to reach a long-term competitive advantage, using employees' knowledge is essential in fulfilling that goal. Nevertheless, it is not enough to only use the actual employees' knowledge basis. Based on Grant [1], a firm is conceived as an institution for knowledge integration. The knowledge-based view (KBV) of the organization places knowledge as the fundamental source for achieving competitiveness and views the organization as a system that develops, integrates, and shares knowledge together with coordination of employees who possess the knowledge to create the organization's value [2], [3], [4]. Anwar [5] examines in his work the influence of psychological dimension and personality on knowledge management and knowledge sharing. The KBV is based on the presumption that knowledge can only be managed but not completely controlled [2]. Therefore, organizations need to manage their employees, knowledge, and competencies, which could be done through human resource management practices [6]. One of the first articles examining companies' human resource management (HRM) appeared as early as the 1970s. Still, the increase in scientific articles on the topic appeared twenty years later. Many scientific papers have focused on human resource management and its influence on a company's performance [6], [7], [8], [9] and other possible perspectives linking knowledge management and HRM practices [10], [11], [12], [13] and more. As the link between knowledge and human resources was mentioned in many studies, the authors aim to provide an in-depth literature review, including directions and innovative journeys that contribute to the overall knowledge of the professional public.

Nonaka [14] identified knowledge as "tacit" and "explicit". The concept of tacit knowledge, which includes knowledge not articulated, not easily visible, and hard to formalize and express [15], is linked to senses, motor skills, and intuition and is a foundation of organizational knowledge creation theory. According to Nonaka and Takeuchi [15], tacit knowledge can be divided into two dimensions: technical (informal and hard-to-detect skills or procedures captured in the term "know-how") and cognitive dimension (consisting of beliefs, schemes, mental models, and perceptions that reflect our image of reality and the vision of a future). On the contrary, explicit knowledge is something formal and systematic. It is expressed in words and numbers and documented through drawings, written materials, scientific formulae, and codified procedures or principles [15], [16].

In contrast to the resource-based view of the firm, which considers the firm's capabilities as sources of competitive advantage, the knowledge-based theory focuses on the knowledge embedded in individual employees and the firm as a whole [1], [17]. Based on that, the companies' primary resource is knowledge, which employees own and can only be used by the individuals who possess it. It is important to provide a set of activities and processes which aim to effectively manage knowledge as based on Bindra et al. [18]: "the internal knowledge is required to be aligned with the innovative organizational processes where an individual's knowledge in the organizations is integrated with the organizational knowledge base". For instance, knowledge management is a concept that provides processes and capabilities for managing knowledge [2]. The definition of the knowledge management process varies among different scholars. According to Kaur [2]: "knowledge management refers to a set of processes aimed at effective management as well as utilization of organizational knowledge that in turn can facilitate a firm in creating value, enhancing performance and gaining a strategic edge over other players in the market". Knowledge management capability is a mechanism which intentionally and continually creates knowledge within the organization and ensures utilization of knowledge to produce knowledge synergies [2], [19]. Many scholars had discussed the concept of knowledge management process capabilities, for example Spender [20] defined knowledge management as the creation, transfer and application of knowledge. According to Alavi and Leidner [21] the process of knowledge consists of at minimum four basic concepts: knowledge creation, storage, transfer and its application. Grant [1] argues that in the task of production, creating, acquiring, storing and deploying knowledge are fundamental activities of the organization.

Another significant concept regarding knowledge as a strategic resource is dynamic capabilities (DC), which have recently begun to be explored by researchers and practitioners based on knowledge [2], [18], [22], [23]. Dynamic capabilities are part of strategic management, the study of dynamic capabilities is interdisciplinary, and subsequently, they are part of organizations' internal resources concerning resource-based theory [24]. Based on Zheng et al. [25], dynamic capabilities are the ability of an organization "to acquire, generate and combine knowledge resources to sense, explore and address environment dynamics". According to these authors, knowledge-based dynamic capabilities have three dimensions: knowledge acquisition, knowledge generation, and knowledge combination capabilities. Knowledge acquisition capability is the capability of an organization to identify and obtain external knowledge. Knowledge generation capability demonstrates firms' ability to establish and refine processes that facilitate the generation of new knowledge. And finally, knowledge combination capability refers to the firm's ability to integrate internal and external knowledge. Kaur [2] differentiates knowledge management process capabilities on knowledge acquisition, knowledge

combination, and knowledge protection. The first two mentioned had been defined briefly above, so there is a need to define what knowledge protection is. According to Kaur [2], based on other authors [26], [27], knowledge protection includes processes in order to restrict access to vital information and increase barriers by infusing various aspects into the knowledge. Dynamic capabilities are dependent on a flow of learning, integration and transformation, and the implementation of knowledge management processes could help organizations in creating a competitive advantage based on knowledge [3], [28]. Apascaritei and Elvira [29] differentiate among three types of HRM dynamic capabilities according to their role in knowledge building, integration and reconfiguration. HRM DC that sparks knowledge building includes knowledge management and learning capabilities. These DC allow firms to accumulate and store knowledge and apply it as a lever for innovation. Knowledge and intellectual assets and developing competencies of human resources should be a primary activity to gain a competitive advantage and overcome the company's competitors in today's competitive and unexpected world [12], [30]. However, human resources are the ones who create, share, and use knowledge. The ability of organizations to use and leverage such knowledge depends on the willingness of humans to share it [13]. To develop human resources competencies within the company or acquire human capital with the required skills and knowledge from the external labor market, companies take advantage of human resource management (HRM) practices [12].

Human resource management practices consist mainly of selection, training, development, appraisal, and compensation for employees [9]. Effective human resource management practices could be a considerable advantage for a company. High-standard HR processes attract potential employees and retain motivated and qualified ones. Higher product quality, higher profitability, less turnover of employees, or faster acceptance of the company's strategy could affect the HRM concept [6].

In other words, human capital could be an essential character of organizational competitiveness, economic performance, and innovation, especially in knowledge-based environments [32]. Organizational desired goals are reached through the behavior and skills of the employees. The knowledge and human resource management perspective appear to be a highly integrated approach [13]. Based on Grant [13]: "The danger inherent in the concept of organizational knowledge is that, by viewing the organization as the entity which creates, stores and deploys knowledge, the organizational processes through which individuals engage in these activities may be obscured." Thus it is important to engage employees in collaboration and learning so that the knowledge does not stay only within the head of individuals. According to Minbaeva, Foss and Snell [32], integrating knowledge and HRM must be a research priority. According to Yahya and Goh [10], knowledge management is an evolved form of HRM using IT as the supporting mechanism in employees' collaborative process and interaction. Therefore, conducting a comprehensive review of the literature on the linkage of knowledge and human resource management practices is crucial to enrich and to update existing literature and set new research directions for the topic.

In the literature, dozens of valuable articles focused on the literature review of various aspects covering the linkage of human resource management and knowledge. The chapter is dedicated to a brief overview of the most important literature review studies on this subject. Birasnav et al. [12] developed a systematic literature review to investigate the interrelationship between transformational leadership, knowledge management (KM) and human capital to achieve a competitive advantage. The review paper was mainly integrated using a model which suggested that HRM should provide training to managers regarding the development of transformational leadership behavior. Such behavior contributes to human capital creation, leading organizations to gain a competitive advantage.

Ordóñez de Pablos and Lytras [6] analyzed an extensive literature review on HRM, organizational learning, and human capital towards increasing organizational performance. The main output of the study confirmed that human resource systems could support the development and/or use of competencies of the organizations; however, such systems might not be enough to reach a competitive advantage. Nevertheless, the specific human resource practices configurations should be searched to ease knowledge creation, transfer, and standardization.

Antunes and Pinheiro [13] researched the link between KM, organizational learning and memory. The review was developed on a total of 2,511 scientific articles between 1960 and 2017. Due to the research, managers should pay special attention to the knowledge associated with the organization's concept. The knowledge could be encouraged by a set of collaborative practices of HRM, and organizational learning could be considered a dynamic process based on the knowledge and organizational memory as the output.

Majeed [11] aimed to show the association between KM, knowledge sharing and HRM practices in knowledge-intensive firms by studying the publications from 2000 to 2006. The study found that organizations should pay attention to the variable personnel demands and extensive training and development needs of knowledge workers. The author suggests that HRM practices need further research to contribute to the theoretical and practical development of knowledge-intensive firms (KIFs) and other organizations. Cross-cultural research in small KFIs, especially in SMEs, is lacking. The work of Hislop [33] aims to improve our understanding of what shapes workers' willingness (or reluctance) to share their knowledge.

Scarbrough [34] focused on the implications of KM for human resources and management practices, and Hislop [33] developed the linkages between HRM and KM. According

to Hislop [33]: "The KM literature has acknowledged the importance of people management themes, but has not made the next step of investigating and theorizing these issues in detail."

Articles focusing on systematic literature review papers are often based on a limited number of scientific papers. As Asmussen and Møller [35] point out, manual exploratory literature reviews should be the past. The number of scientific articles focused on knowledge, and HRM is growing so fast that capturing currents, topics, and developments in individual subject areas is practically impossible with manual approaches.

Technology development allows using a more effective approach, such as machine learning and using big data as a new innovative journey of in-depth literature review on a specific topic. In the introduction, there is documented a strong connection between HRM and knowledge. We identified this as a literature review gap and used this approach to identify main directions, topics, journeys, and trends within knowledge and human resource management. This study aims to fulfil this gap by processing metadata to get results from more than 7,000 articles identified in the Scopus database with research directions linked to knowledge and human resources. Authors use big data machine learning based on Latent Dirichlet Allocation (LDA) topic modeling for a smart literature review. The approach aims to answer three research questions:

RQ1: What is the development of academic papers related to the interconnection between human resource arrangement and the role of knowledge in the research interest across selected subject areas, and what are the current trends of HRM and knowledge in the last four decades?

- HRM research is becoming a multidisciplinary field, the application of which can be seen in various subject areas. This research question will allow a better understanding of the position of HRM and knowledge interconnection in individual subject areas and the development of research in the last four decades.

RQ2: What are the dominant research topics related to HRM and the knowledge and development of these topics over time?

- Bibliometric text data hides valuable information, which has been hidden until now and has not been the subject of extensive research. Extracting topics by a machine learning text mining approach can reveal insightful information and open research discussion about HRM and knowledge interconnection.

RQ3: What is the impact of COVID-19 on managing knowledge from the perspective of human resources?

- The Covid pandemic affected almost all areas of human living. We assume that the area studied by us was no exception, and that is why we tried to examine which areas of HRM and knowledge interconnection have seen the greatest research interest during pandemic.

II. DATA AND METHODOLOGY

We used bibliometric analysis based on a novel approach to machine-learning topic modeling to answer the research questions. We preferred to perform a bibliometric review over a systematic literature review for several reasons. Since in a systematic literature review, these review studies deal with in-depth analysis, the scope of the study is often limited and restricted. The bibliometric approach analyzes a much larger number of studies than standard SLR studies. The advantage is thus a more general and holistic overview of the given scientific field. The credibility of the results is also related to the mentioned fact. This applies especially when analyzing large subject areas. It is thus possible to capture patterns and understand developments even in large scientific fields. Although SLR studies mostly analyze 100-200 documents, this analysis is time-consuming. Processing thousands of studies in this way would be practically impossible. The bibliometric approach thus represents a suitable alternative in some cases.

In addition, the potential of using artificial intelligence and machine learning is enormous and provides new possibilities for data processing. Therefore, in addition to the standard bibliometric approach, we also used machine learning tools and applied a new approach - the so-called smart bibliometric analysis. This innovative approach extends the standard bibliometric analysis and brings additional advantages. We applied smart bibliometric analysis to research questions RQ2 and RQ3. This approach provides the organization of documents into topics based on the content of the documents. This approach adopts classic SLR because it can analyze a much larger number of studies. The performed smart analysis is less detailed and deep than with classic SLRs. However, the smaller depth is worth the tradeoff when processing a much larger sample of documents.

We used the following data-acquisition procedure to get data to answer our research questions described in part 2.2: The first step was defining the eligibility criteria. In our case, our criteria were scientific articles on human resource management and knowledge. In the second step, we chose a representative information source. We have opted for the Scopus scientific database, which is sufficiently important and contains many documents, i.e., it is a precondition for the representativeness and robustness of our results. In the third step, we set the search criteria, which in our case, we defined for the search in Article title, Abstract, and Keywords. The next step was to define a search query that was: „human resource management" or „hrm" and „knowledge". Finally, we restricted the results for the period 1969 - 2021. The reason for defining this interval was to determine the period when the authors began to publish papers about HRM. The final number of documents that met our Scopus search criteria was 7,318 documents (as of December 15, 2021).

To answer the research questions, we matched the obtained documents with their affiliation to one or more of the 26 subject areas 1, defined in the Scopus database. The resulting

dataset thus contained, in addition to basic information (authors and title of the article, publication year, name of the journal, number of citations of a paper, text of the abstract), also information about subject areas.

To answer a research question RQ1, we performed descriptive data analysis. In this analysis, we used the following summary metrics: number of articles, number of new articles, and cumulative percentage shares of articles. We also analyzed the essential human resource management and knowledge journals. In addition, we also structured the descriptive analysis according to individual subject areas to determine which subject areas this theme is most represented. We also structured particular topics by year to capture the dynamics of the development of specific topics.

Except for descriptive data analysis, we also used advanced data modeling methods. The reason was to answer the research questions RQ2 and RQ3. Within RQ2, we tried to identify the topics represented and addressed in knowledge-based human resource management from 1969 to 2021. We conducted this research through a machine learning approach, using the Latent Dirichlet Allocation (LDA) method [36]. To capture the relationships between subject areas and topics, we used circular compositions based on the Circos package [37]. To answer the research question RQ3 (''what is the impact of COVID-19 on managing knowledge from the perspective of human resources''), we used the co-occurrence map of the terms related to the Covid-19 pandemic. The whole flowchart of the methodological process is shown in Figure 1.
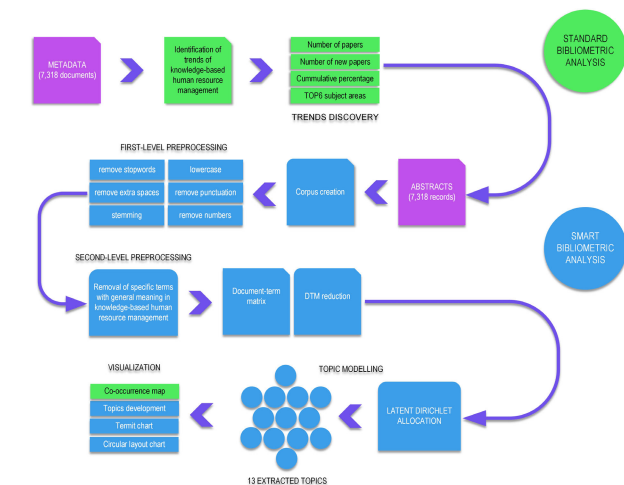

FIGURE 1. Methodology of our research based on bibliometric data.

Latent Dirichlet Allocation is used to model topics within a text dataset. It is an unsupervised method that is based on the composition of words. It divides the entire text (documents) into thematic probability clusters, a mixture of individual words. In addition, the documents are a mixture of particular topics [38]. The LDA method is formally defined as follows. Let us have LDA hyperparameters, α (document-topic density) and β (topic-word density), then, according to

Blei et al. [36] we can define a continuous distribution of the probability mixture of θ, the set N of mixture z and the set N of words w as

$$p(\theta, z, w \mid \alpha, \beta) = p(\theta \mid \alpha) \prod_{n=1}^{N} p(z_n \mid \theta) \, p(w_n \mid z_n, \beta) \quad (1)$$

By calculating the product of marginal distributions of individual documents, we get the probability of the corpus as

$$p(D \mid \alpha, \beta)$$
$$= \prod_{d=1}^{M} \int p(\theta_d \mid \alpha) \left(\prod_{n=1}^{N} \sum_{z_n} p(z_n \mid \theta_d) \, p(w_n \mid z_n, \beta) \right) d\theta_d \quad (2)$$

where D is the corpus and $d = 1 \ldots M$ are the individual corpus documents.

As mentioned above, in our case, the purpose of LDA modelling was to create topics that are relevant to knowledge-based human resource management. For this purpose, we used the dataset of 7,318 abstracts of documents from the Scopus database. The topic modelling included a pre-modeling phase and a modelling phase. Before modelling the topics, we changed the data structure to the corpus type and then preprocessed the data. In the pre-processing phase, we performed: lowercase procedures, removal of punctuation, removal of numbers, removal of unnecessary words, removal of extra spaces and stemming. In addition, we also removed words with general meaning in knowledge-based human resource management. Subsequently, we reduced the created dtm matrix by words with a number of less than seven and more than n (number of documents). We also removed words that were less than four or more than 20 characters in size.

We performed several experiments in the topic modeling procedure. Their purpose was to find such a number of topics k that would appropriately represent the field of knowledge-based human resource management. In LDA topic modeling, topics are created based on posterior expectations. These can be implemented in several ways of quantification; we have chosen the method of Gibbs sampling [39]. We performed experiments with the number of topics k = 8, 9, 10, 11, 12, 13. The final selection of a suitable number of topics was made by an expert assessment. The final topics were subsequently visualized using the LDAvis library [40].

The text mining and topic modeling as well as topics visualization was implemented in the statistical software R. R provides the possibility of using additional functions through R packages and thus contains many functions for advanced and specific statistical data processing, including methods for modeling topics. Such advanced statistical functions are not available by default in standard statistical software. In addition, the R software is also a programming language, and calculations are thus realized by writing programming code. The advantage is the high level of automation, replicability,

and flexibility of the created solution. Finally, the R software is freely available and thus provides the possibility to use all functions without a license and simultaneously completely legally. The replicability of our methodology thus increases, as it is also accessible for free.

III. FINDINGS

We identified representations of knowledge-based human resource management across several subject areas on the sample of 7,318 publications. Figure 2 provides an overview of the trends of knowledge management research in HRM in the top six subject areas from which BUSI, COMP and ENGI are the most dominant. Business subject is the one in which the most papers, including the new ones (year 2017–2020) were created. Given the nature of knowledge management in an organization, it is meant that most of the papers are covered in the subject BUSI which is directly related to the management of organizations (BUSI) and such knowledge management initiatives could not properly work without any information and information technology (COMP), that is the reason why the COMP subject area is the second most dominated one.
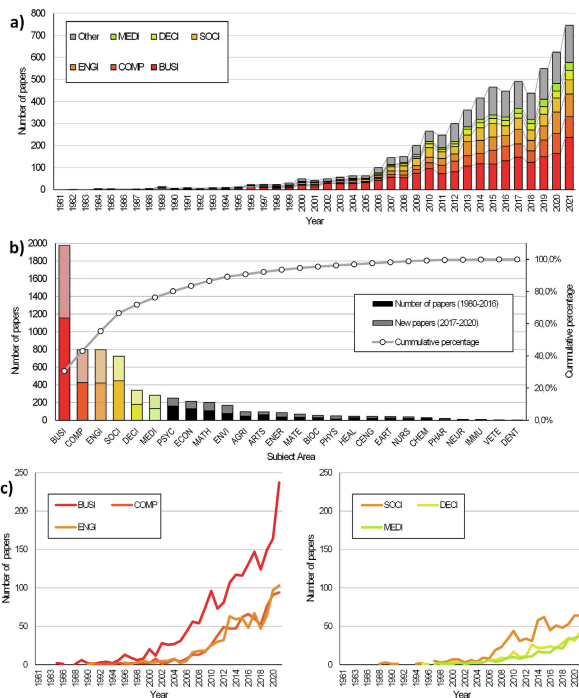

FIGURE 2. a) trends of knowledge management research in HRM in top-6 subject areas; b) share of new papers in all subject areas; c) development of number of papers in top-6 subject areas.

The growing knowledge and human resource management trend could be seen especially in the last year's period. The BUSI subject area has been growing since the year 2000. However, the BUSI area is not the only one growing. In the other two essential research areas, COMP and ENGI, the growing trend could be seen since the year 2007. The increasing number of articles related to HRM and knowledge management research is also shown Figure 2c). Based on that,

TABLE 1. Journals related to knowledge management research in HRM.

Journal	Subject area	All papers	All citations	Top paper	Citations of top paper
International Journal of Human Resource Management	BUSI	138	5469	[7]	911
Human Resource Management	BUSI, PSYC	53	2917	[41]	358
Journal of Knowledge Management	BUSI	39	2513	[10]	289
Journal of Management	BUSI, ECON	12	2128	[42]	519
Journal of International Business Studies	BUSI, ECON	13	1833	[32]	720
Journal of Cleaner Production	BUSI, ENER, ENGI, ENVI	29	1810	[43]	811
Academy of Management Journal	BUSI	3	1807	[7]	1746
Human Resource Management Review	BUSI, PSYC	37	1658	[44]	311
International Journal of Project Management	BUSI	33	1585	[45]	203
International Journal of Information Management	COMP, SOCI	35	1382	[46]	195
International Journal of Manpower	BUSI	42	1381	[34]	267
Employee Relations	BUSI	41	1348	[33]	312
Information Systems Research	COMP, SOCI	6	1283	[47]	676
Personnel Review	BUSI, PSYC	49	1193	[32]	133
Academy of Management Review	BUSI	2	1187	[48]	649

it could be stated that the number of published articles in the study is growing every year.

Table 1 illustrates the most relevant journals in the field of knowledge management in relation to human resource management. The list below shows the overview of the top 15 journals in the mentioned area. The journals are ranked by the total number of citations, and except for the two journals, the BUSI subject area occurs.

The abstracts of the analyzed documents contained a set of different words (terms), which were the basis for using
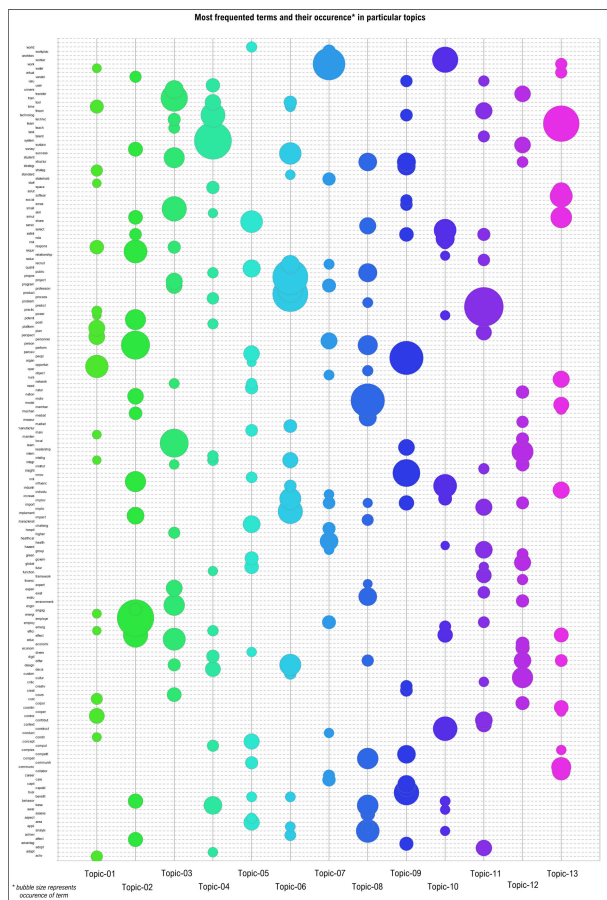
FIGURE 3. Most frequented terms in identified topics.

LDA. Using text clustering, we identified 13 relatively unique topics related to knowledge management research in HRM. Figure 3 provides an overview of the 191 most frequently used terms and their assignment to particular topics.

Based on the composition of terms in individual topics, we identified the names of these topics. At the same time, the content of the most important articles on this topic was considered in these so-called topics. We examined the mutual interconnectivity of the topics, which did not show a high degree of overlap. Thus, it can be stated that the LDA has identified 13 relatively unique topics, which are closely described below:

Operational planning (Topic-01) – the topic is based on the terms "oper", "plan", "personnel", "control" and "requiring". Within this topic, research focuses on various components of planning, such as ecosystem effects management [49], food safety knowledge [50], and food waste management [51]. In related articles, operational planning can be seen as planning strategic goals and objectives from the high level into more specific lower-level goals and objectives.

Employee performance (Topic-02) – this topic forms the terms „employe", „perform", „effect" and „relationship".cThe research on the topic is focused on how performance appraisal and compensation systems should be

designed, so employees are encouraged to knowledge-sharing practices within the company [52]. Another research shows that intellectual capital positively influences the relationship between the company's innovation performance and knowledge-based Human Resource Management practices [53].

Skills learning (Topic-03) – the third topic consists mainly of the terms „learn", „train", „skill" and „educ".The topic includes various papers; for example, one paper reviewed the literature on the knowledge, skill and ability requirements for teamwork [42]. Another one identified which skills are missing between the graduating students and how the shortage of knowledge could be prevented [54].

Technological systems (Topic-04) – the topic is formed mainly by the following terms: „system", „technolog", „base" and „tool". The topic focuses on what is the role of HRM systems in managing knowledge [55] on intelligent decision support in medical emergency management [56] or on the concept of the digital skin of the future intelligent construction site – such as augmented reality, labour tracking, and building information model-based visualization, and more [57].

Public service challenges (Topic-05) – the topic consists mainly of the terms „servic", „public", „challeng" and „people". Within the topic, research focuses on various aspects, such as the product services for a resource-efficient and circular economy [43], enterprise social networks, which have been receiving increased attention in academia [58]. Public service innovation and innovative hybrid organizations can creatively combine co-existing logic [59]. This is a less important topic concerning research interest and impact.

Project-based learning (Topic-06) – in this topic, „process", „project", „product" and „implement" are the most frequent terms. Within the topic, the impact of integration management on construction projects was studied [60]. Knowledge transfers and project-based learning in large-scale infrastructure development projects, this paper investigated how managers and engineers active in state-owned enterprises learn from each other and how they share working experience in the mentioned projects [61].

Employee profession (Topic-07) – the seventh topic consists of most of the terms „work", „health", „profession and „employ". Papers within the topic focused, for example on how the physical environment could affect the creativity of knowledge workers compared with the effects of creative personality and the social-organizational work environment [62]. The role of human resource management specialists in implementing innovation was analyzed [63].

Employee competencies (Topic-08) – the next topic consists of the most frequent terms, which are „model", „analysi", „compet" and „performance". The research focuses on work enrichment and employee voice in human resource management performance studies [64] or, for example, on the interaction between structural capital and human capital in chosen non-profit organizations [65].

Organizational innovation (Topic-09) – the topic consists mainly of the terms „organ", „innov", „busi" and „strategi". In this section, for example, the role of knowledge management capability and environmental dynamism in SMEs concerning open innovation was examined. Boon et al. [66] investigated the integration of strategic human capital and strategic human resource management.

Risk management (Topic-10) – the topic is formed primarily by the terms „worker", „safeti" and „risk". For example, safety management practices and safety behavior about the role of safety knowledge and motivation were studied [67]. This is a less significant topic concerning research interest and impact.

Human resources issues (Topic-11) – the eleventh topic is made up mainly of the terms „practic", „group" and „contribut". For instance, analysis of human assets and management dilemmas were studied [48]. Chiappetta Jabbour et al. [68] on the research agenda of the human side of the circular economy.

Sustainable economy (Topic-12) – this topic consists mainly of the terms „intern", „cultur", „global" and „sustain". Research within the Management Information Systems on sustainability was conducted [69]. This is again a less important topic concerning research interest and research impact.

Team collaboration (Topic-13) – topic 13 covers terms such as „team", „social", „share" and „communication". Within the topic, research focuses on relational archetypes – entrepreneurial and cooperative. The study identified how human resource configurations could be linked to the strategic management of relational archetypes [70]. The research investigated how vital trust in the project is as trust grants access to valuable knowledge of outside project partners [71].

Figure 4 shows the composition of the topics concerning the subject areas. BUSI is the most represented subject area. It makes up half of Topic-02, Topic-11 and Topic-12. Topic-02 was named Employee performance, and with regards to today's economy, employees, in other words, human capital, are the most valuable asset for an organization's success and competitive advantage. Cabrera and Cabrera [52] identified performance appraisal and compensation as factors of people management practices that foster knowledge flows within the organization. Topic-11 was named a Human resources issue and similar to Topic-02 it is also highly connected to organizational performance. Guest [8] linked the HRM and performance outcomes of the organization in his research. Based on the study, organizations need to measure Human Resource Management outcomes (for example, the commitment of the employees, quality, and flexibility) to understand how HRM impacts overall performance. Topic-12 was named Sustainable economy as sustainability is a vital factor in the world as there is the rapid depletion of natural resources, and society is concerned about the corporate responsibility of the organizations [69].
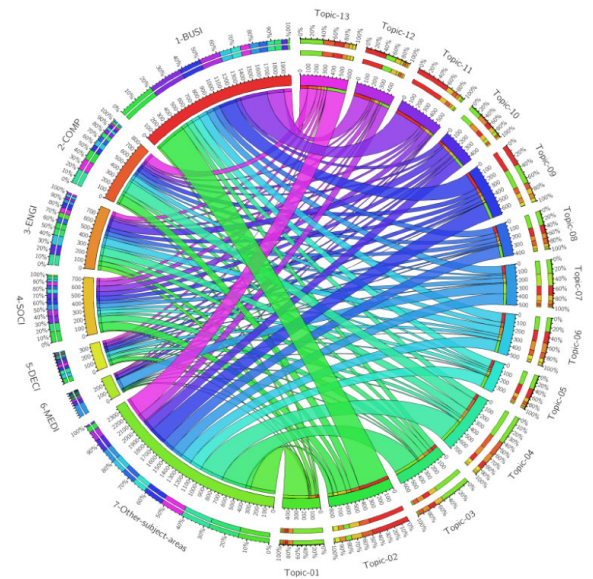

FIGURE 4. Relationships between topics and subject areas.

Since each of the 13 topics was paired with a certain number of articles, it was possible to perform time analyses of the development of the topic. Figure 5 provides an overview of the development of particular topics over the last 20 years. In the upper part, there is a development about the number of published articles; in the lower part, there is a development in relation to the number of citations of articles published each year.

Based on these results, scientific interest (measured by the number of published articles) is growing mainly in Topic-02 and Topic-10. Topic-02 is also the topic with the most significant number of published articles. As mentioned in the text earlier, Topic-02 is named Employee performance, which is an important factor for organizations to fulfil their goals. Human resource management practices impact the performance of individuals and the whole organization. Topic-10 was named Risk management which is connected to organizations' ability to operate within dynamic environments which could be affected by internal and external forces. Strategic HRM could help organizations foresee the future. For example, the construction industry is one of the largest employment sectors and is considered the riskiest and most dynamic environment. According to Loosemore, Dainty and Lingard [72], the HRM strategy's role is to capitalize on opportunities and mitigate threats through its people-management policies. It could also be seen that the importance of strong topics of the past had gradually decreased – this applies to Topic-09 and Topic-13. Other topics are approximately stable over time. Topic-09 was marked as Organizational innovation which could be linked to the organizational ability to use HRM practices focusing on employees' existing knowledge and skills to innovate. The role of HRM systems in innovation support seems like a reasonable way to gain new insights about it [55]. Topic-13 was named Team collaboration which is essential for

organizational function. However, team collaboration could be influenced by many factors within the organization. For example, Maurer [71] investigated the effects of trust in inter-organizational projects, and the results show that such a factor is advantageous in these kinds of projects. The results of the research also show that project staffing, as well as project rewards, are factors that may contribute to the formation of trust.
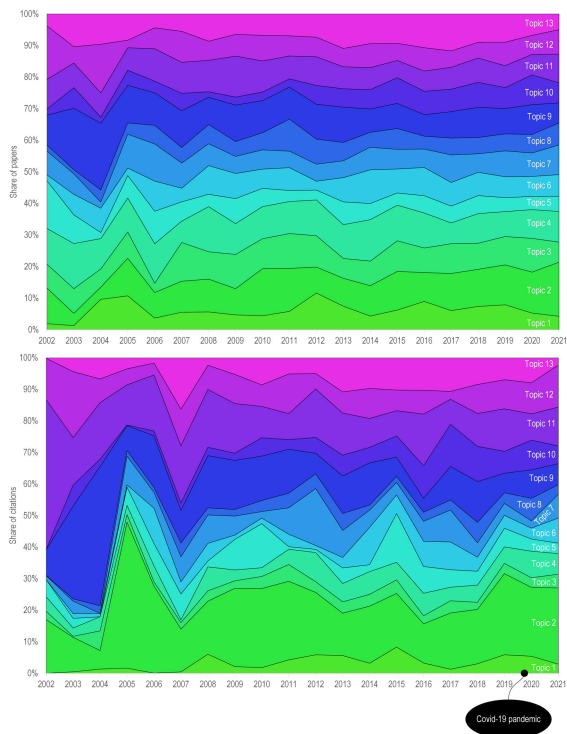

FIGURE 5. Topics development in the last 20 years (share of papers and share of citations).

Looking at the research interest of individual topics (measured by the number of citations), it could be seen that Topic-02 and, in recent years, Topic-12 and Topic-13 have the greatest impact on the scientific community. Topics 03, 05, 06, 07, and 08 have a relatively low number of citations throughout the observed time period, and their impact on the direction of knowledge management research in HRM is relatively low. These topics were named as follows: Topic-03 (Skills learning), Topic-05 (Public service challenges), Topic-06 (Project-based learning), Topic-07 (Employee profession), and Topic-08 (Employee competencies) and these topics had a relatively small impact on the direction of KM research in HRM comparing to other HRM-related topics.

In recent years, the ratio of topics has changed, as it could be seen that even stable topics have changed in the last two years due to the Covid-19 pandemic.

Since 2020, the Covid-19 pandemic has affected virtually all scientific fields. From our full dataset (7,318 articles), we filtered records containing terms such as "Covid-19" in the document's title, keywords, or abstract. This gives us

57 documents under the influence of the pandemic. Based on the "Covid-19" keyword, we identified four general areas which illustrate the co-occurrence map in Figure 6. The co-occurrence map below contains terms related to the Covid-19 pandemic and knowledge and HRM. Based on the identified keywords, we named these four general areas: responsible communication, coordination of knowledge, leadership aspects, and global effect.
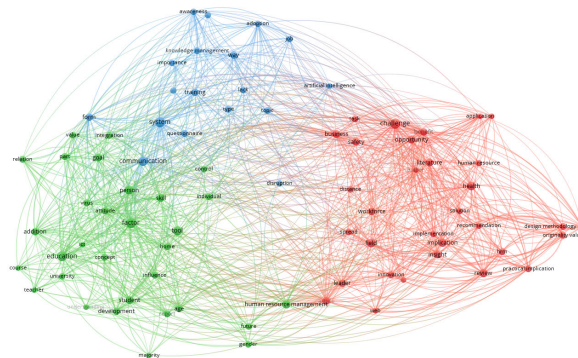

FIGURE 6. Co-occurrence map of terms related to Covid-19 pandemic.

The following part covers four areas related to the Covid-19 pandemic, which authors identified based on the originally used dataset from Sopus. General areas discussed in 57 papers related to the Covid-19 pandemic are described as follows:

Responsible communication - the aim of the research conducted by Caligiuri et al. [73] was to address critical aspects preventing a suitable risk evaluation. Therefore, a suitable risk assessment process should guide the adoption of appropriate risk communication and management strategies. Vahdat [74] reviewed articles related to the role of technology in human resource management in the Covid-19 area. The study found that web-based solutions, for example, cloud computing, could address a vital resource allocation gap within organizations.

Coordination of knowledge - the pandemic had an impact on organizational performance as well as on employees resulting in a decrease in business profit and sustainability of organizations. Due to Chaudhari, Nakhate and Rautrao [75], HR has a significant role in crisis management. HR leaders could set the perspective and prevent organizations from overreaction by providing employees with correct knowledge regarding the coronavirus and the organisation's current state. Moreover, according to Al Shehab [76], people are the most valuable assets within an organization, as their qualifications, skills, and experience are keys to constant success through changing market conditions. Therefore, it is essential to manage the organization's knowledge at an all-time to ensure that it will remain in the company even if the crucial employees leave the organization.

Leadership aspects - articles focused on the leadership aspect are mainly in the field related to health and medicine. Salas-Vallina, Ferrer-Franco and Herrera [77] undertook

interviews with medical staff to examine relationships among shared leadership, social capital, and contagion rates. Results of the research show that shared leadership positively affects Covid-19 contagion among healthcare staff, and it plays a fundamental role in improving performance in healthcare.

Global effect - Covid-19 pandemic and its measures (for example, travel bans, reduced mobility of people, home office, etc.) affected the local market but international business overall. International HRM had to address various pandemic challenges, for example, in practices such as employee selection, training, leadership or virtual cooperation [73]. The covid-19 pandemic brought unique challenges for organizations worldwide, including managing employees effectively.

Except for these four general categories, we summarize the main findings on human resources and knowledge from papers related to the topical issue of the Covid-19 pandemic. Ahmed et al. [78] conducted a quantitative study in which a positive and significant impact of employee engagement and knowledge sharing on organizational performance was proved. Minbaeva [79] points out that the pandemic period brought three global mega-trends: the flexible workforce, the digitalization of business models, and artificial intelligence and machine learning, and it is crucial to support HR practitioners with the knowledge needed to respond to disruptions caused by these trends. Al Shehab [76] focuses on how this pandemic influences knowledge management within the entity and how they can recover from this situation adequately. It provides recommendations to conserve knowledge management even when some employees leave the business.

IV. DISCUSSION

Linking the topics of knowledge and human resource management has existed in the literature for several decades. Professional articles and their authors deal with the links of this topic to human resources and address other contexts, such as technological aspects, or the link to individual professional fields such as mathematics or medicine.

We started this research to understand in-depth the relationship between knowledge and human resource management in the literature registered in Scopus since 1969. Using big data, we got a unique data set and identified the link between human resource management and the role of knowledge in the research interest and research impact across various subject areas. To sum up the paper, we brought answers to three research questions:

RQ1: What is the representation of knowledge-based human resource management across different subject areas, and what have been the trends of HRM and knowledge in the last four decades?

- Based on the descriptive data analysis, we found that the number of published articles in the study has been growing yearly. In the main six identified categories, including business as the most significant, nearly 2000 papers were published in the examined period. This confirms the authors' assumption of a significant connection between HRM and knowledge in the business subject area.
- Based on performed LDA topic modelling, we identified 13 relatively unique topics related to knowledge management research in HRM. We captured the dynamics of developing specific topics and the relationships between subject areas and topics. We identified the most important topics in business: employee performance, human resources issues and a sustainable economy.

RQ2: What are the topics related to HRM and knowledge and their development over time?

- Our research has identified 13 topics related to HRM and knowledge research. Articles related to performance management and risk management topics were identified as those where employee performance is the topic with the highest number of published articles and cited articles. It shows the significance of managing knowledge within human resources on employee performance topics.

RQ3: What is the impact of COVID-19 on managing knowledge from the perspective of human resources?

- We found out that the impact of the Covid-19 pandemic influences the future direction of managing knowledge from an HRM perspective. Our research has identified four main areas to research on the Covid-19 pandemic and human resources and their knowledge. These are coordination of knowledge, responsible communication, leadership and global effect. These areas could be considered as those giving the directions and calling for further practical and theoretical research.

The themes identified in the analysed dataset are often known in the scientific space. Several literature reviews and research-oriented studies have focused on addressing different aspects of the topic. Table 2 presents some scientometric data on the identified topics. At the same time, the table lists the most influential journals (concerning the total number of citations) and the most influential papers on the topic. Thus, these influential articles can be confronted with the identified topics, and their similar or different features can be discussed.

The first topic identified was Operational planning. Within this topic, the most influential reference is the one that was published by Klemeš [80]. In the Handbook of Process Integration (PI): Minimisation of Energy and Water Use, Waste and Emissions, the author pays attention to process integration (PI) in energy-intensive industries. The book offers a comprehensive view of various process design and integration topics. The book was quite popular in the field of operational planning in the earlier period but did not cause a significant increase in research interest or research impact that created a snowball effect.

Regarding the Topic-02 Employee performance, the most influential article within our researched data set is the one by Cabrera and Cabrera [80]. In this theoretically-based article, authors examined how human resource practices could foster a chosen process of knowledge management - knowledge

TABLE 2. Overview of scientometrics data of identified topics.

Topic	NP	PL5	TC	TJ	NP-TJ	TC-TJ
Operational planning	474	154	2779	Handbook of Process Integration	1	267
Employee performance	826	343	15383	Int. Journal of Human Resource Management	26	1509
Skills learning	644	215	3719	MIS Quarterly	1	570
Technological systems	753	224	4937	IEEE Intelligent Systems and Their Applications	1	542
Public service challenges	384	119	6840	Academy of Management Journal	1	1746
Project-based learning	520	168	3884	International Journal of Project Management	12	512
Employee profession	514	194	5232	Neurogastroenterology and Motility	2	665
Employee competencies	418	146	2653	Int. Journal of Human Resource Management	2	178
Organisational innovation	669	209	11293	Information Systems Research	4	1260
Risk management	445	191	4857	Journal of Construction Engineering and Management	34	760
Human resources issues	576	189	13153	Int. Journal of Human Resource Management	54	2271
Sustainable economy	491	164	7548	Int. Journal of Human Resource Management	54	2271
Team collaboration	604	186	6498	Academy of Management Review	1	538

LEGEND: NUMBER OF PAPERS IN TOPIC (NP); PAPERS IN LAST 5 YEARS (PL5); TOTAL NUMBER OF CITATIONS IN TOPIC (TC); TOP JOURNAL (TJ); TOTAL NUMBER OF CITATIONS OF TOP JOURNAL (TC-TJ); NUMBER OF PAPERS IN TOP JOURNAL (NP-TJ); TOP REFERENCE (TR).

sharing. Authors identified that intentions to share knowledge are determined by positive attitudes toward sharing knowledge as well as perceptions of sharing norms. Since this particular article had been published, the influence of the topic was emerging.

Skills learning was identified as Topic-03, and based on research papers the most influential one is by Denis et al. [81], in which authors paid attention to critical skills and knowledge requirements of information systems professionals. The study suggests that information systems professionals would need knowledge and skills in the following areas: business operations, technology, interpersonal skills, and management. Based on the analysis of the share of

papers and citations, the articles in this topic did not cause a significant increase within the area.

Topic-04, called Technological systems, was another examined area in which the most influential paper from the data set is an article by Staab et al. [82] called. Within their research, authors did a meta process that puts special emphasis on constructing and maintaining the ontology when introducing knowledge management systems. Authors furthermore proposed two dimensions of knowledge processes in which they recommend brother analysis, namely knowledge meta process and knowledge processes that are performed while running a knowledge management solution. In our research, we examined papers that were also related to HRM systems in managing knowledge, and common characteristics with this topic are considerable.

Public services challenges have been identified as the next Topic-05. In this topic the most cited paper is by Becker and Gerhart [7]. It examined how HRM decisions influenced organizational performance and suggested areas in which the research may be further undertaken. Since the paper publishing the research interest had recorded a few significant changes in the research interest and research impact trends.

Within the Topic-06 called Project-based learning the most influential paper from our dataset is by Teixeira et al. [83]. Authors, for example, revealed that green training may also be a source of green organizational learning and knowledge because it is related to the adoption of green purchasing and consumers across the supply chain. The research showed that green training in alignment with human resources practices is crucial to the greening of firms which is very topical due to organizational sustainability. Our research revealed the stable trend of this topic.

Employee profession is the next Topic-07 in which the most influential article is by Bredenoord [84] but does not correspond to our research interest as it is about Neurogastroenterology and Motility. However, in our research we mentioned articles related to innovations in association with HRM specialists [63] and creativity of workers [62]. The research interest within the topic was rather steady.

The next identified theme was Topic-08 called Employee competencies in which Wood and Wall [64] studied work enrichment and employee voice in HRM. According to literature, organizations gain a competitive advantage by possessing a set of resources, capabilities, and core competencies that are valuable, uncommon among competitors, and difficult and costly to imitate. Based on these specifics, organizations could build their core knowledge. This is another research that shows the significance of HRM practices in relation with knowledge and therefore gaining a competitive advantage. However, our investigation did not reveal high research interest or impact of this topic.

Regarding Topic-09 Organisational innovation, the most influential article within our researched data set is the one by Armstrong and Sambamurthy [47]. Authors examined knowledge-based and resource-based theories of the company in order to investigate the influence of quality of senior

leadership, sophistication of IT infrastructures and organizational size on IT assimilation based on a large-scale sample survey of CIOs and senior business executives. It is a topic of relatively constant interest.

Topic-10 called Risk management was studied by various researchers and the most influential one from our database is a paper by Vinodkumar and Bhasi [67]. Employee perceptions of six safety management practices and self-reported safety knowledge, as well as other safety areas, were assessed in this study. The most important safety management practice that predicts safety knowledge, motivation, compliance, and participation, was identified as safety training. This topic had gained in importance, especially during the Covid-19 pandemic when the health of all of us was in danger and appropriate business processes and HRM practices needed to be adopted for the global functioning system.

Human resource issues were identified as Topic-11, one of the most influential topics within our research. Under this theme of our dataset the most important paper is by Guest [8], who proposed a model to provide a linkage between HRM practices and organizational performance. The topic has relatively high research interest compared to others.

The next Topic-12 called Sustainable economy is a less interesting topic within our research, but the most influential paper within the theme and defined dataset is article by Minbaeva et al. [85] in which the relationship between MNC subsidiary HRM practices, absorptive capacity, and knowledge transfer was investigated. The article did not cause a significant increase in research interest or research impact that would lead to an overall significant effect.

Finally, Topic-13 called Team collaboration was examined and the most influential article on the topic within our data set is by Kang et al. [70] who studied relational archetypes, organizational learning, and value creation in order to extend human resource architecture. Based on the share of papers and citations within the theme it is evident that team collaboration records an increase in research interest and research impact in recent years.

We analyzed knowledge-based human resource management across different subject areas in the first research question. From the analysis, we found that a relatively large part of the papers related to the investigated issue falls into Computer Science (COMP) and engineering (ENGI) categories. The mentioned phenomenon may be related to the fact that mining knowledge from data is a complicated and demanding process for which statistical methods are commonly used. In addition, current research increasingly emphasizes that rapidly developing knowledge management technologies are an effective tool for achieving business results and developing human resources [86]. That is why the articles in this area overlap with the subject areas COMP and ENGI.

Moreover, the dramatic development of technologies and their use during disruptive events leads us to assume that more and more research on KM and HRM will be devoted to technical disciplines such as COMP or ENGI. From a practical point of view, knowledge in the field of data science and computer science will become essential for the further improvement of business management. Therefore, it is likely that companies will have difficulty being competitive in the future unless they can mine corporate knowledge using the above tools. Therefore, we recommend that companies invest their resources in qualified human capital in the future, i.e. to recruit qualified employees with skills in data science.

However, business research (BUSI) is growing more than in the field of COMP or ENGI. The increase in the number of articles over the last few years has been dramatic. Even though knowledge management is often associated with information sciences, practical research overlaps with HRM and can be seen primarily in business. The difference in the approach to KM from the point of view of computer science (COMP) and business (BUSI) subject area is fundamental. Approaches to knowledge management in the field of COMP focus primarily on technologies and processes, the efficiency of which is a predisposition for successful business solutions and results [87], [88]. On a practical level, this finding has several implications. The massive increase in research in the BUSI field will probably impact the business environment as well. In times of uncertainty and unpredictable disruptive events, organizations will probably consider the cost/benefit ratio more when choosing and implementing various KM technologies. The relevant criterion for deploying the technology will not be the degree of automation that the technology will bring but, above all, the ratio between the value created and the investments in these technologies.

By analyzing the trends, we found that the subject of knowledge-based human resource management has been growing consistently and significantly over the last few years. The mentioned trend is most evident in the subject area of business (BUSI). It is related to the fact that businesses and the economy are increasingly focusing on human resources and knowledge. The entire society is being transformed into a knowledge-based economy. Thus, employees become the most vital asset for the company, and companies increasingly realize this.

Moreover, managing people well is becoming critically important to companies worldwide. If companies realize these facts, they can gain a competitive advantage. This is also probably why there is such an increase in research on these topics, which is precisely related to the practical overlap of these problems. This phenomenon is also confirmed by the number of published articles in this area over the last five years. In addition, new subtopics, such as knowledge hiding. If companies want to be competitive, we recommend that they focus on the area of knowledge management.

By analyzing unstructured text data, 13 relatively unique topics were identified using LDA topic modelling. The BUSI area, which is most relevant for knowledge-based HRM, contains the largest representation of topics from the topics Employee performance (Topic-02), Human resource issues (Topic-11), and Organizational innovation (Topic-09).

Articles from the mentioned topics are probably the most important. It may be related to the fact that these topics are considered a priority in knowledge-based HRM. Another explanation could be that the research in these areas is the most varied and includes possible problems related to the investigated issue of KM-HRM. Therefore, most of the problems businesses face may involve topics from the three abovementioned topics. In the case of successful business operations, these areas should therefore be considered critically important for companies.

It is also important to note that in terms of content, the topics Skills learning (Topic-03), Project-based learning (Topic-06), Employee competencies (Topic-08), and Team collaboration (Topic-13) are close to each other. However all four cases are about employee competencies, three specific groups were singled out from this topic: skills learning, project-based learning, and team collaboration. This may have something to do with the fact that the articles related to a given area are consistent and well-differentiated within the broader group of "employee competencies". Due to the homogenous structure and the sufficient number of documents, the LDA algorithm merged the mentioned documents into three separate groups. The above shows that these topics are strongly represented in knowledge-based HRM. Based on the above, we recommend that when hiring and further training employees, emphasis should be placed on these three competencies: skills learning, project-based learning and team collaboration, as they appear to be key competencies for employees in today's knowledge economy.

The analysis of the development of the identified research topics showed a long-term permanent interest in the topic Employee performance (Topic-02). In addition to the permanent research interest in Employee performance, we also identified a growing interest in risk management research (Topic-10). This is understandable, as businesses often face many threats in this disruptive world. A series of unpredictable crises, such as the pandemic, global problems in supply chains, and the effects of the war in Europe, reveals the vulnerability of companies. This naturally leads researchers to the development of risk management. It is, therefore, critically important that even today, businesses attach adequate importance to risk analysis and can quantify it quickly and accurately. A study by Becker and Smidt [89] already drew attention to the need to consider risk perspectives. The trend of increasing scientific interest in risk management related to HRM was confirmed in our study. At the same time, it can be added that research is currently focused on more specific risk aspects such as e.g. operational risks, personal risks, professional risks, human capital risks and contextual risks [90]. In the future, such deeper specialization may influence the modification of standard HRM processes, such as hiring, training, and development or compensation and employee benefits.

Three of the identified 13 topics will probably belong to important research areas in the following years: Employee performance (Topic-02), Human resources issues (Topic-11),

and Sustainable economy (Topic-12). Research in employee performance can be based on semi- or fully-automated technologies using artificial intelligence, which will make it possible to increase the efficiency of an individual or the entire organization. Emerging technologies like robotic process automation can shift human work to software robots [91]. KM fundamentally changes how we work with information, and our results suggest that it will likely affect the development of core HRM functions. We assume that the currently valid paradigms in the field of HRM will have to undergo a dramatic revision to be able to capture the dynamics with which technologies are changing us, e.g. hiring processes [92], [93], (online) working in teams [94], sharing experiences [95], [96], [97] and so on. From a business perspective, we expect an increase in interest in the sustainable aspect of digitalization. Several current studies suggest that digital technologies contribute to economic, social, and environmental sustainability [98], [99]. From the perspective of research in BUSI, sustainability is a critical factor for most technology-oriented studies, and KM is not excluded. We anticipate the practical impact of our findings in a stronger emphasis on employees' digital skills, which will be an important prerequisite for knowledge management.

The pandemic was also a game-changer in the field of HRM, and our results show that this was also manifested in the form of research interest and research impact. In the pandemic years 2020 and 2021, the topic Employee performance (Topic-02) dominated among articles related to HRM and knowledge. Another topic that, in terms of the share of publications in the researched area, grew during the Covid pandemic was Human resources issues (Topic-11). Although the topic of Human resources issues seemed to be on the decline in the long term, with the arrival of the Covid-19 pandemic, companies were forced to deal with many more problems related to employees. It concerns e.g. quarantine measures, travel restrictions, lockdowns, etc. It is, therefore, evident that the mentioned consequences were also reflected in the number of publications from this subfield of research. It was related to the increased amount of business problems in the world. Based on the above, it can be argued that in the event of another pandemic or disruptive situation in the world, the demand for articles on the mentioned topic will increase again.

In addition, by analyzing the most frequently occurring relevant words that were identified in articles related to Covid-19, the following can be deduced:

- businesses began to place increased emphasis on technology, and the competencies needed for their use,
- companies began to rapidly transform into digital organizations, which is related to the ability to use the home-office institute or online learning better,
- the topic of knowledge sharing became even more relevant during the pandemic.

The topics that, in terms of the share of publications in the researched area, decreased during the Covid-19 pandemic

were Operational planning (Topic-01), Skills learning (Topic-03), Organizational innovation (Topic-09), and Team collaboration (Topic-13). The Covid-19 pandemic has changed the priorities of companies around the world. Companies had to face completely different problems that became a new priority. Topics such as online education, digitization, and working under limited conditions have become topical. The above is related, for example, to problems in the supply chain, failure of ordered goods, problems with transport, low demand, or changes in customer behavior.

Analysis of articles related directly or indirectly to the pandemic revealed several potential directions for future research. The first is the coordination of knowledge, while some studies indicate that the challenge will be primarily to coordinate the use of heterogeneous technologies in complex socio-technical settings [100]. The second is responsible communication, which so far remains only a latent topic in the literature. At the same time according to the composition of the articles, its starting points go back to the theory of corporate social responsibility or green HRM. The pandemic also profiled a third prospective topic: leadership, and according to some studies, authentic leadership is a critical factor in times of crisis [74], [101]. While in most cases, research is a trendsetter in the practical world, in the case of a pandemic, it was often the opposite - companies often improvised and looked for (often new) solutions that were able to quickly react to a dramatic change in practically the entire business ecosystem. The three topics mentioned above can influence a stronger anchoring of the new principles of complexity, sustainability, and leadership in the business environment. Another potential area for research can be using LDA for a smart literature review of practically any research domain with dynamic development. In our study, we pointed out the analysis possibilities offered by the combination of standard bibliometric tools with progressive machine learning procedures, especially the discovery of latent topics by textmining procedures.

We identified several research limitations in our research. Even though we believe these limitations did not significantly impact the credibility of the presented results, they will now be elaborated on in more detail. The first limitation is failing to analyze the research issue's current state through a standard method such as a systematic literature review (SLR). Although the SLR method is the de-facto standard for similar analyses, we analyzed the researched area using a bibliometric and machine-learning approach. Although it is obvious that the depth of the performed analysis cannot be the same as in the case of SLR, thanks to our approach, we analyzed a much larger number of papers and thus provided a more holistic view of the researched scientific area. In addition, machine learning enabled us to identify latent topics and thus perform an analysis in greater depth than only with a standard bibliometric approach. From the point of view of insightful information, the performed smart machine learning bibliometric analysis is even closer to the SLR method.

The second limitation is using abstracts in data mining from the text through the LDA machine learning method. The results would be even more credible if we used document abstracts as inputs to the LDA model and entire scientific articles. However, as the abstracts contain the essential information and summarize the methodology and results of the article, it can be assumed that if the full texts of the articles were used, the results would be comparable to those from the abstracts.

The third limitation is a possible problem when creating a search query. In the case of defining a search query, we defined knowledge, hrm and human resource management as search words. The mentioned words also have synonyms in the English language. It is, therefore, possible to believe that if we included relevant synonyms of these words in the search query, we could get an expanded dataset. However, since these words are technical terms in the given field, we decided not to combine synonyms, as we could also expand the dataset with irrelevant documents.

The fourth limitation is also related to the search query. It is clear that the word knowledge has a broad meaning; therefore, a search for only this keyword would include a large number of irrelevant documents. We solved this problem by adding words like hrm and human resource management. Although it is possible that in the result of the corpus of documents, there were articles unrelated to the given issue and irrelevant, we believe that the number of such articles was minimal due to the good composition of the search query.

The fifth limitation is related to the number of created topics. There are several approaches to determining the number of topics. The statistical approach monitors selected statistical indicators (such as perplexity) and determines the number of topics based on the selected criterion function. Our approach consisted of the manual human assessment of individual options. Although from a statistical point of view, it is possible that the criterion function of the resulting solution was not optimal, we selected a number of topics that were consistent in terms of the composition of individual words and documents.

Topics are also subject to a limitation regarding their names. Topics consist of a large number of documents (abstracts). Defined names of topics may thus contain a certain degree of subjectivity in naming the topics. Moreover, it is unrealistic that the two- or three-word naming of topics completely unambiguously and precisely corresponds to all the articles that appeared in the mentioned group. Our effort was to use a holistic approach to use a topic name that would reflect many articles on the given topic as representatively and reliably as possible.

Finally, it is evident that topics are a mixture of individual articles, and an article is a mixture of individual words. However, individual words occur frequently, even in different types of articles. Therefore, it is apparent that it is impossible to assign an article to the selected topic with a 100 percent probability. Our result was in the form of a probabilistic representation of the affiliation of individual articles to a

given topic. Based on the maximum probability of affiliation, each article was subsequently assigned to the topic with the highest probability. The articles are a mixture of individual words based on which individual topics are created.

V. CONCLUSION

Data is one of the companies' biggest assets in the age of IT technologies, globalization, artificial intelligence, and Industry 4.0. Using data and extracting information from it will be one of the most sought-after skills in the future. Data often represents a competitive advantage for businesses or organizations, adds value, and provides additional insightful information. Scientific databases represent a considerable source of valuable information for further scientific and technological progress. However, the amount of data these resources contain is growing exponentially and is a severe problem. Classic human-based processing often becomes infeasible due to time constraints. For the above reason and other reasons described, we decided to use an alternative approach to the standard one (systematic literature review) when processing the current state of the issue of knowledge-based human resource management. Moreover, with increasing computer performance and the development of computer science, artificial intelligence is beginning to make progress. The paper uses a bibliographic analysis that presents the results using descriptive statistics. In addition, we also used a novel approach called smart bibliometric analysis. This approach uses a combination of text analytics and machine learning to extract even more insightful information. We used a clustering method named Latent Dirichlet Allocation to create unique topics related to knowledge in managing human resources. The smart bibliometric approach opens up new ways of processing review studies using hundreds to thousands of documents that were once impossible. With the development of data processing tools, the number of review studies based on bibliometric and smart bibliometric approaches is starting to increase. We are therefore convinced that this approach will gradually become a standard in processing review studies in various scientific disciplines. It also allows for authors to use this approach for other, more specific directions of knowledge management. Other common influences of aspects in knowledge management identified in this in-depth analysis as knowledge sharing or knowledge hiding from the perspective of individuals, teams and the organization.

Our review confirms the importance of the link between knowledge and HRM in the business area. Moreover, the study provides valuable and insightful information. The uniqueness of the data set used for the paper provides a reader with a complex overview of this research area for the last decades and catches current trends in the previous two years. In addition, we also consider the topicality of our study related to the Covid-19 pandemic valuable. Finally, the main contribution of this paper is the extent of the review, as such a broad study has not yet been published in the field of knowledge and human resource management.

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