Structure of human resource management in the information technology field: A bibliometric analysis

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Abstract. Human resource management (HRM) involves huge amounts of data, which requires the application of modern information technologies (IT). The paper looks at the role and development of human resource management in information technologies by employing bibliometric analysis of publications released in the period of 2001–2020 and aims to understand the interaction between the two fields. The methodological basis includes the concept of human resource management. In the article, the bibliometric methods were used, such as co-word, social network and keyword frequency analyses. The information basis of the study includes 562 articles indexed in Scopus database. The data obtained were processed using VOSviewer, Pajek and UCINET software. The 20-year period under study was divided into four periods of five years each to interpret the combination of methods, betweenness centrality and degree centrality values of the keywords for each period. Social network analysis findings reveal that sustainable HRM studies in the IT field are cohesive and connected, and appear to be building as an academic field. According to the research findings, human resource development, cloud computing, supply chain management, and job satisfaction are the most likely study fields in the future. Developments in the field of HRM provide a subjective assessment and interpretation of the emerging trends based on the quantitative approach and identify the existing research gaps, such as looking for an association between IT and sustainable HRM social effects.

Keywords: human resource management; information technology; bibliometric analysis; co-word analysis; social network analysis.

Структура управления человеческими ресурсами в области информационных технологий: библиометрический анализ

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Аннотация. Важным аспектом успешного управления человеческими ресурсами (УЧР) является эффективное использование больших массивов данных, обработка которых требует привлечения информационных технологий (ИТ). Статья посвящена изучению роли и развития концепции УЧР в области ИТ на основе библиометрического анализа публикаций 2001–2020 гг., а также установлению степени взаимосвязи между указанными сферами. Методологическая основа работы представлена концепцией управления человеческими ресурсами. Использовались методы библиометрического анализа, в частности анализ совпадающих слов (co-word analysis), социальных сетей и частоты употребления ключевых слов. Информационную базу исследования составили 562 статьи, проиндексированные в базе данных Scopus. Обработка полученных сведений осуществлялась с помощью программных продуктов VOSviewer, Pajek и UCINET. Методика работы предусматривала разделение рассматриваемого периода на пятилетние интервалы с расчетом степеней центральности и посредничества для наиболее употребляемых ключевых слов для каждого из этих интервалов. Результаты анализа социальных сетей подтвердили взаимосвязь сфер УЧР и ИТ, а также согласованность их развития как смежных академических областей. Установлено, что наиболее перспективными для дальнейшего изучения направлениями развития человеческих ресурсов являются облачные вычисления, управление цепочками поставок и удовлетворенность профессиональной деятельностью. Эти разработки позволяют получить субъективную оценку и интерпретацию тенденций в области УЧР на основе количественного подхода, а также выявляют исследовательские лакуны, одна из которых – изучение социальных эффектов, вызванных тесным взаимодействием сфер УЧР и ИТ.

Ключевые слова: управление человеческими ресурсами; информационные технологии; библиометрический анализ; анализ совпадающих слов; анализ социальных сетей.

INTRODUCTION

Human resource management (HRM) has been a core component of both business schools and management studies since it emerged as an attempt to resolve the failures of personnel management, human interactions, and industrial relations by providing directions on how organizations should deal with people for superior organizational efficiency and individual satisfaction [Marciano, 1995]. Beginning with the 2000s, information systems and the Internet set out a new era in HRM. HRM, which involves huge amounts of data that render decision-making difficult, is mostly affected these days by technology, as well as by many other factors such as government regulations and laws. Advancements in technology have brought with it more progress in HRM functions such as performance management, training and growth, talent management, recruitment, and wages [Bussler, Davis, 2002]. The information technologies in HR are defined as the collection, coordination and reporting of employee information [Basu et al., 2002], as well as the systems that are built mainly for the information management of organizations [Martinsons, 1997]. IT is considered a sub-cluster of information and communications technology (ICT) [Zuppo, 2012]. It allows for improved management decision-making with better information, and is used to develop competitive products or services in HR [Broderick, Boudreau, 1992]. The use of IT in HR made it possible to (a) increase competitiveness by improving HR operations; (b) produce a higher number of and more diversified HR reports; (c) shift the focus from processing to strategic HRM; (d) integrate employees into information management; and (e) restructure companies' overall HR functions [Ngai, Wat, 2006].

With the use of information technologies, human resource practices have been transformed from labour-intensive function to technology-intensive one [Florkowski, Olivas-Lujan, 2006]. IT significantly supported countries' development while helping the integration of workforce by facilitating access to information, forming a public domain with mass communication tools, and removing the barriers for people's participation in the economy by creating opportunities [Chacko, 2005]. In the intensive competitive environments, changes in organizations moved towards more flexible formations in which expertise and continuous training are the key. In this framework, ICT provides the necessary support to the company by facilitating coordination and flow of information [Orlikowski, 1996; Rockart, Short, 1989]. ICT focuses especially on the company's personnel organization and the demand for certain skills and talents [Rusu, 2010].

There have been an increased number of bibliometric studies on HR in recent years [Fernandez-Alles, Ramos-Rodríguez, 2009; García-Lillo, Úbeda-García, Marco-Lajara, 2017; Markoulli et al., 2017; Qamar, Samad, 2021; Danvila-del-Valle, Estévez-Mendoza, Lara, 2019; Kainzbauer, Run-gruang, 2019]. Similarly, bibliometric studies have risen in the IT field. The citation analysis by López-Herrera et al. [2012] highlights the management theme and suggests that future studies may be impacted by notions such group decision-making, forecasting, governance, analytic-hierarchy-process, and performance assessment. In bibliometric study on cloud computing by Yu et al. [2018], not only mobile cloud computing, big data, security and storage concepts come to the fore, but also concepts such as business economics and resource management remark. The development of mobile devices together with information technologies have profoundly altered people's daily lives, along with the spread of e-communication, e-commerce and e-government, and with the construction of smart cities [Zhang et al., 2019]. Iwami et al. [2020] conducted citation analysis with 14,438 academic articles. The conclusion of the study provides recommendations of themes such as information technologies, cloud computing, and decision-making in organizations.

Reviews that investigate HR and IT together reveal that current studies are limited to specific areas. Marler and Fisher [2013] investigate e-HRM and strategic HRM notions of 40 studies, while Marler and Boudreau [2017] focus on the development of HR analytics. Additionally, current literature reviews examine the interaction between HR and IT from an HR perspective. Gonzalez, Gasco and Llopis [2020] conducted a detailed and systematic literature review on the use of information technologies in HRM in the context of tourism. From another perspective, Oehlhorn et al. [2020] put forth in their systematic literature reviews that HR plays an undeniably significant role on strategic business-IT alignment.

As explained above, current reviews of the HR and IT fields focus on specific subjects and areas. Consequently, there is a need for comprehensive and holistic research on the role of HR, especially in the IT field. It is evident from previous studies that HR management and practices are gaining more importance and being researched more in fields associated with IT, such as IT competency [Crawford, Leonard, Jones, 2011], software development projects [Park et al., 2015; Chiang, Lin, 2020], big data analytics [De Mauro et al., 2018], and cloud computing [Ziebell et al., 2019]. There is also notable disconnect between HRM and IT studies due to the lack of explaining the association between HRM and the use of IT in the literature.

In this respect, the study aims to investigate the role, development and evolution of HR in the IT field and explore the interaction between the two fields through science mapping. We seek answers on the following questions by using co-word and social network analysis to put forward the conceptional evolution of HRM studies in the IT field.

Research Question 1: What are the changes in the subject trends on HRM studies in the IT field between 2001 and 2020?

Research Question 2: What are the main areas of research of HRM studies in the IT field?

Research Question 3: What are the areas of research associated with HRM studies in the IT field?

Research Question 4: What are the themes that are fading or emerging in HRM studies in the IT field?

Research Question 5: What is the direction that HRM studies in the IT field may take in the future?

This study investigates HRM studies in the IT field with a quantitative approach and provides a subjective and qualitative evaluation of the literature. It also presents a comprehensive perspective of HRM studies in the IT field, examines the emerging trends and tries to serve as a useful guide for future studies by identifying gaps in the literature.

The article is structured as follows. Section 2 explains research methodology in the context of co-word analysis, social network analysis and the data collection method. In Section 3, the research data are examined using co-word analysis and social network analysis methods to provide findings on the direction that HR studies in the IT field took between 2001 and 2020. Finally, the discussion and conclusion section considers the findings, offers recommendations for future studies and covers the limitations of the research.

THEORETICAL BACKGROUND

In bibliometric analysis, there are two main procedures to explore a study field: performance / citation analysis and science mapping. Performance analysis aims to assess the scientific group of actors (countries, universities, departments, researchers) and the impact of its operations based on bibliometric data. Science mapping strives to present the structural and dynamic aspects of scientific fields, draws the boundaries of a research field, and measure and visualize the sub-sections that have been identified by co-word analysis or co-citation analysis [López-Herrera et al., 2012]. While the study follows science mapping procedure, it also employs the co-word analysis and social network analysis to exhibit the conceptual structure of disciplines as well as their development and evolution.

Co-word analysis. Co-word analysis (the unit of analysis are concepts) is applied on document titles, keywords, abstracts and full texts [Zupic, Čater, 2015]. Co-word analysis puts forward the norms and trends in a discipline by measuring the connection strength of the terms that represent the relevant publications produced in this field. The main specification of co-word analysis is visual mapping of the intellectual and conceptual structures of a specific discipline [Ding, Chowdhury, Foo, 2001]. In co-word analysis, when two keywords that describe a certain research subject appear in the same article, they are considered to have an intrinsic relationship. The quantification of the matching between these two keywords show the strength of the relationship. This method helps researchers learn the general overview and limits of a discipline. Thus, it provides an important reference value that supports the development of academic disciplines [Yang, Wu, Cui, 2012].

Social network analysis. SNA is often used by various disciplines such as sociology [Edelmann et al., 2020] anthropology [Burt, Opper, Zou, 2021], psychology [Duan, Zhu, 2020], communication [Fu, Lai, 2020], economy [Truc, Claveau, Santerre, 2021], and management science [Lin, Padliansyah, Lin, 2019]. Researchers use SNA to examine the structure of communities, define network structures and model current connections by visualizing the relationship between the communities [Su et al., 2019]. SNA regards the relationships important in the context of social life and considers as a starting point the proposition that the relationships are created by developing patterns in this field [Wasserman, Faust, 1994]. SNA (1) conceptualizes social structure as a network that connects the members and directs the resources, (2) focuses on the particulars of the networks rather than those of individual members, and (3) sees communities as "personal communities," in other words, as personal relationship networks that people nurture, maintain and use throughout their daily lives [Wetherell, Plakans, Wellman, 1994]. Relationships are the main point of SNA [Otte, Rousseau, 2002]. Connections between the actors are defined as the associations and relationships. In this context, each keyword is accepted as an actor as well [Uyar, Kılıç, Koseoglu, 2020].

Dataset. The data used in the study were retrieved from the Scopus database, which was launched in 2004. This database is considered a reliable source of bibliometric studies [Zupic, Čater, 2015; Gerdsri, Kongthon, Vatanan, 2013; Hanisch, Wald, 2012; Walter, Ribière, 2013]. The searching and limitation process applied in the study is presented in Fig. 1. At the end of the process, 562 studies were selected and analysed.

- The Scopus database was reviewed for the titles of "HR" OR "HRM" OR "HUMAN RESOURC*."
- Number of resources: 10,487

- Selected field: Computer Science
- Number of resources: 2,056

- Selected years: 2001–2020
- Number of resources: 1,841

- Only articles were selected
- Number of articles: 615

- The 615 articles retrieved were checked manually. Non-HR-related articles were excluded.
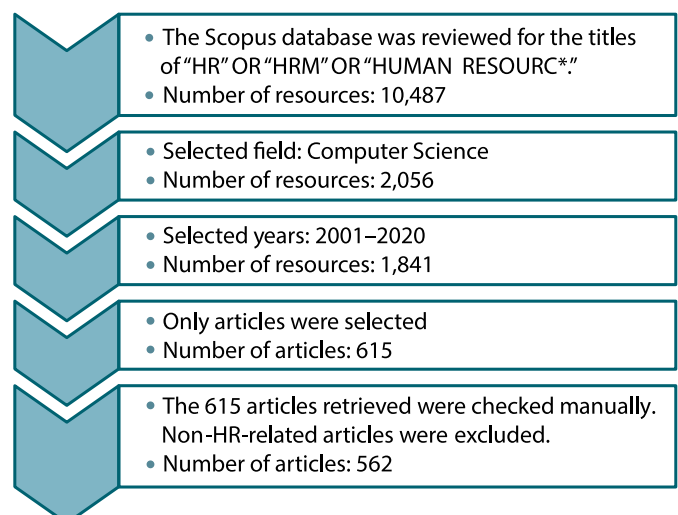- Number of articles: 562

Fig. 1. Data collection and limitation process
Рис. 1. Процесс сбора данных и ограничения выборки

ANALYSIS AND RESEARCH FINDINGS

General findings. Table 1 shows the distribution of HR-related articles in IT journals according to the years between 2001 and 2020. According to Table 1, the majority of articles were published in 2019. There is no particular increase or decrease in the number of articles by years. However, the numbers of articles increased periodically based on a five-year assessment of the published articles (Fig. 2). Accordingly, most articles were published between 2016 and 2020.

Keyword frequency analysis. The research investigated the most frequently used keywords in the articles published in the past 20 years by dividing up this period into four quarters of five years each, and by also looking into all of the years between 2001 and 2020 to examine the conceptual change in the HRM keyword. Table 1 shows the most frequently used top-20 keyword fields for each period. Since the research subject is HR studies in the IT field, "human resource management" was the most frequently seen keyword in these periods. This is a reasonable conclusion considering the nature of the co-word analysis. Therefore, the "human resource management" keyword was not included in the interpretation.

"Human resource practices", "e-HRM" and "knowledge management" are the most frequently used keywords according to the review of the HR articles in the IT field for the past 20 years as shown in the "all periods" column in Table 1. Despite some declines in the ranking periods, "in-

Table 1 – Frequency of keywords
Таблица 1 – Частота использования ключевых слов

| 2001–2005	n	2006–2010	n	2011–2015	n	2016–2020	n	All periods	n
Keyword	n	Keyword	n	Keyword	n	Keyword	n	Keyword	n
Human resource management	5	Human resource management	16	Human resource management	45	Human resource management	88	Human resource management	154
Human resources development	2	Organizational performance	5	Knowledge management	7	Human resource practices	19	Human resource practices	22
Manpower planning	2	Information technology	4	Data mining	5	Cloud computing	10	E-HRM	15
Agent	1	Human resource practices	3	Performance evaluation	5	E-HRM	12	Knowledge management	13
Agent coalition formation	1	Genetic algorithm	3	Human resource allocation	4	Supply chain management	8	Cloud computing	13
Artificial worlds	1	AHP	2	Innovation	4	Performance	7	Organizational performance	11
Decision making	1	Case study	2	AHP	3	HR Analytics	6	Performance	11
Focus groups	1	Data envelopment analysis	2	China	3	Organizational performance	6	Human resource allocation	10
Branch and bound	1	Human capital	2	Cloud computing	3	Employee performance	5	Information technology	10
Electronic commerce	1	Motivation	2	E-HRM	3	Empowerment	5	Human capital	9
Business policy	1	Outsourcing	2	HRM practices	3	Human capital	5	Supply chain management	9
Business-to-business marketing	1	Performance	2	Human resource development	3	Knowledge management	5	Genetic algorithm	8
Communications technologies	1	Resource allocation	2	Management	3	Job satisfaction	5	Human resource development	8
Competences	1	Skills	2	Information technology	3	Motivation	5	Training	8
Computer simulation	1	Absenteeism	1	Academic libraries	2	Training	5	Data mining	7
Computer-integrated manufacturing	1	Academic libraries	1	Balanced scorecard (BSC)	2	Artificial intelligence	4	Job satisfaction	7
Computerised tool	1	Accuracy analysis	1	Business intelligence	2	Fuzzy logic	4	Motivation	7
Consumers	1	Aggregation operators	1	Case study	2	Simulation	4	AHP	6
Control	1	Analytic network process	1	Global databases	2	Information system	4	Employees	6
Critical resource diagram	1	Decision supports	1	Customer relationship management	2	Information technology	3	Knowledge sharing	6
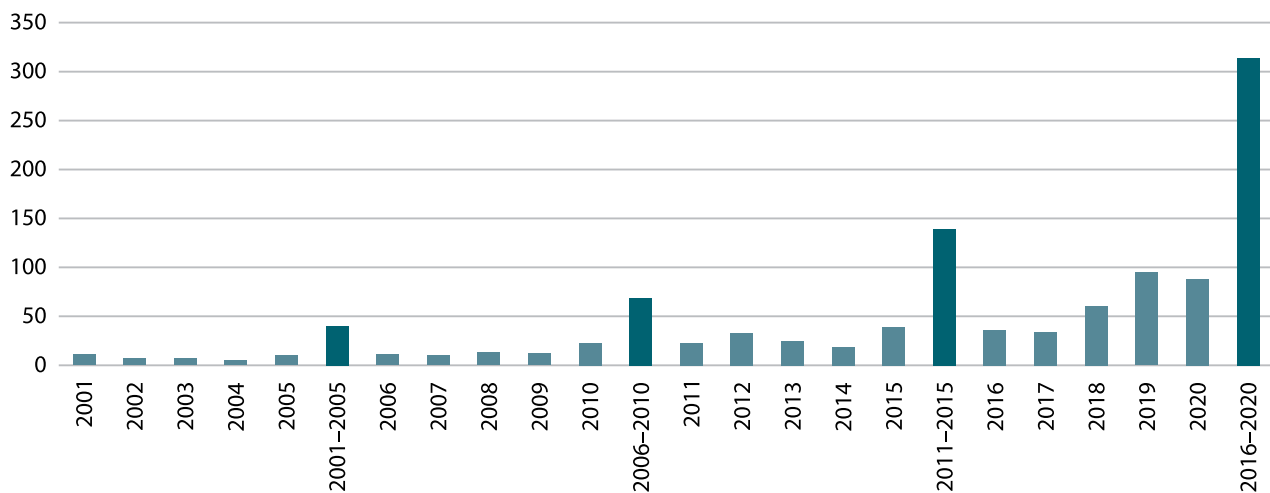
Fig. 2. Number of HRM articles in the IT field in 2001–2020
Рис. 2. Количество статей по УЧР в области ИТ, 2001–2020

formation technology" is among the most used keywords over the years. Meanwhile, the usage frequency of "cloud computing" and "e-HRM" keywords appear to be on an upward trend.

Social network analysis. Table 2 presents some important indicators of the co-word network in this research. First of these indicators is average degree. The number of total relationships that a keyword has is expressed as a degree, while the average of all the keywords' degree in a network is defined as average degree [Andrikopoulos, Kostaris, 2017]. A high average degree in a co-word network means that the general connectedness degree is also high in the network [Wang, Chen, 2003, Costa et al., 2011]. The average degree appears to rise incrementally per period in the HR and IT fields. The average degree for all years is 5.871. This shows that the general connectedness degree in network is increasing and that subsequently, the research themes in the field are assessed in a more connected way with each other.

The second indicator is the network's density value. This indicator takes a value between 0 and 1. Its function is to show the ratio of the number of the connections which a keyword has to the number of all possible connections in the network [Khan, Wood, 2015; Andriko-poulos, Kostaris, 2017]. The research data reveal that the density value is decreasing periodically between 0.005 and 0.044. The density value for all years together is 0.003, which indicates that 0.3 % of all possible connections in the network are realized.

In the social network analysis, a component represents the isolated sub-networks at which the nodes connect to each other internally [Hanneman, Riddle, 2005; Khan, Wood, 2015]. In other words, components are sub-network clusters that have no connection to each other [Tabassum et al., 2018], and they represent smaller but meaningful networks within the general network. There are 86 components, disconnected sub-networks, in HR and IT fields for all years are on an increasing trend. The increasing number of components appears to explain the periodic decrease in the network's density value.

Connectedness and fragmentation values are the other important indicators that are assessed when interpreting the network in general. The connectedness value indicates which actors are connected in the network, and the segmentation value shows how the network is divided into clusters [Shimada, Sueur, 2014]. Increasing connectedness value – and in parallel with it – decreasing fragmentation value, indicates that the co-word network

Table 2 – Network indicators
Таблица 2 – Показатели сетевого анализа

Indicator	2001–2005	2006–2010	2011–2015	2016–2020	All periods
Node	76	225	489	1098	1706
Link	252	1008	2504	6358	10016
Average degree	3.316	4.480	5.121	5.791	5.871
Density	0.044	0.020	0.010	0.005	0.003
Components	15	26	39	58	86
Size of the largest component	13	109	311	851	1339
% of the size of the largest component	17	48	64	78	79
Connectedness	0.068	0.244	0.407	0.601	0.616
Fragmentation	0.932	0.756	0.593	0.399	0.384

has become increasingly tighter and more cohesive [Kılıç, Uyar, Koseoglu, 2019; Varga, 2011]. The study shows that the fragmentation indicator of the research network has gradually decreased in each period, while the connectedness indicator has increased over time. These findings prove that the network has generally become increasingly tighter and more cohesive.

The network created with SNA and co-word analysis based on HRM keywords in the IT field has been examined in terms of the indicators mentioned above. Accordingly, it is observed that the level of connectivity between keywords increases according to the periods.

Social network analysis of keywords. Betweenness centrality and degree centrality indicators were used to conduct a social network analysis of keywords. The most frequently used indicators measure the centrality degree of each keyword within their network [Kılıç, Uyar, Koseo-

glu, 2019]. Betweenness centrality indicator measures the keyword's capacity to connect the other keywords to each other as an intermediary [Sedighi, 2016], while degree centrality shows the number of other keywords to which a keyword is connected [Khan, Wood, 2015]. As seen in Table 3, the same situation found in the frequency table regarding the "human resource management" keyword. "Human resource management" was kept out of the interpretation for similar reasons.

The connection of the e-HRM keyword to the other keywords, or, in other words, the number of times it appeared in the same publications, increased between 2016 and 2020, in comparison to the period of 2011–2015. E-HRM keyword has the sixth highest degree centrality in the past 20 years. Similarly to "e-HRM," the "cloud computing" keyword also increased between 2016 and 2020, in comparison to the period between 2011 and 2015. This

Table 3 – Degree centrality of keywords
Таблица 3 – Степень центральности ключевых слов

2001–2005		2006–2010		2011–2015		2016–2020		All periods	
Keywords	**n**	**Keywords**	**n**	**Keywords**	**n**	**Keywords**	**n**	**Keywords**	**n**
Human resource management	12	Human resource management	29	Human resource management	112	Human resource management	116	Human resource management	199
Information research	4	Organizational performance	15	Data mining	24	Human resource practices	42	HRM practices	54
Brazil	4	Case study	13	HRM practices	16	Cloud computing	37	Performance	47
Oceanography	4	Human resource practices	10	Knowledge management	16	Performance	36	Cloud computing	41
Astronomy	4	Motivation	9	Innovation	15	E-HRM	29	Job satisfaction	37
Artificial worlds	3	Performance	9	Case study	15	Empowerment	25	E-HRM	36
Australia	3	Outsourcing	8	Job satisfaction	15	Supply chain management	25	Organizational performance	34
Business-to-business marketing	3	Data envelopment analysis	7	Management	15	Job satisfaction	24	Training	33
Computer simulation	3	Human tracking system	7	Performance evaluation	15	Knowledge management	24	Information technology	30
Electronic commerce	3	Organizational impacts	7	E-HRM	14	Organizational performance	24	Knowledge management	29
Evolutionary learning	3	Prototype	7	China	12	Training	24	Case study	28
Decision-support systems	2	Resource allocation	6	Cloud computing	12	Information system	24	Motivation	27
Order picking	2	Business intelligence	5	Genetic algorithm	12	Simulation	23	Artificial intelligence	26
		Complementarities	5	Human resource allocation	12	Information security	19	Data mining	25
		Online analytical processing	5	Business intelligence	11	Artificial intelligence	17	Implementation	23
		Analytic network process	4	Decision making	11	Fuzzy logic	17	Information system	23
		Analytical hierarchical process	4	Human resource	11	Information technology	16	Business intelligence	22
		AHP	4	Knowledge sharing	11	Satisfaction	16	Knowledge sharing	21
		Communication technologies	4	Artificial intelligence	10	Human resource development	15	Genetic algorithm	20
		Human resource information systems	4	Information technology	10	Productivity	15	Information security	19

keyword has the third highest degree centrality indicator in the past 20 years. "Artificial intelligence" is not among the keywords in the top-20-degree centrality indicators for the periods of 2001–2005 and 2006–2010. However, this keyword increased in the 2011–2015 and 2016–2020 periods to rank among the top-20-degree centrality indicators in the past 20 years. Furthermore, as with the "artificial intelligence" keyword, "information technology" moved up between the 2011–2015 and 2016–2020 periods to be ranked among the top-20-degree centrality indicators in the past 20 years. An assessment of the trends between the periods shows a gradually increasing connection between IT-associated keywords such as "cloud computing", "artificial intelligence" and "information technology" within the field of IT. This may be an indication that there are an increasing number of academic studies regarding how organizations' human resource functions are tending to integrate with digitalization and technology.

Table 4 shows the betweenness centrality values, which present each keyword's capacity to connect other keywords to each other within the network as an inter-

Table 4 – Betweenness centrality of keywords
Таблица 4 – Степень посредничества ключевых слов

2001–2005		2006–2010		2011–2015		2016–2020		All periods	
Keywords	%	Keywords	%	Keywords	%	Keywords	%	Keywords	%
HRM	0.803030	HRM	0.516153	HRM	0.809043	HRM	0.437471	HRM	0.504752
Artificial worlds	0.000000	Information technology	0.231308	Management	0.199012	HR practices	0.109228	E-HRM	0.066212
Astronomy	0.000000	Organizational performance	0.196983	Performance evaluation	0.121022	Performance	0.092355	HR practices	0.057649
Australia	0.000000	Case study	0.122361	Data mining	0.093036	Cloud computing	0.091369	Performance	0.052458
Brazil	0.000000	Performance	0.105919	Knowledge management	0.075422	Supply chain management	0.080553	Artificial intelligence	0.050848
Business-to-business marketing	0.000000	Resource allocation	0.084141	Genetic algorithm	0.074663	E-HRM	0.070299	Cloud computing	0.048282
Computer simulation	0.000000	Motivation	0.081256	Knowledge sharing	0.072714	Artificial intelligence	0.065436	Job satisfaction	0.038098
Decision-support systems	0.000000	Outsourcing	0.071997	Human resource allocation	0.063326	Motivation	0.043969	Information technology	0.034593
Electronic commerce	0.000000	AHP	0.062882	E-HRM	0.063159	Employee performance	0.041572	Optimization	0.032197
Evolutionary learning	0.000000	Data envelopment analysis	0.054517	Job satisfaction	0.050444	SMEs	0.037099	Organizational performance	0.031038
Oceanography	0.000000	Skills	0.036691	Business intelligence	0.044284	Optimization	0.034534	Information system	0.030673
Order picking	0.000000	HR practices	0.017134	SMEs	0.040624	Framework	0.032479	Motivation	0.028132
Information research	0.000000	Human capital	0.005307	Decision making	0.038083	Hotel industry	0.032204	Knowledge management	0.027981
		Analytic network process	0.000000	Innovation	0.036456	Information system	0.030782	Employees	0.024872
		Artificial neural network	0.000000	HR practices	0.034180	Knowledge management	0.029016	Information security	0.024468
		Business intelligence	0.000000	Knowledge	0.031840	Organizational performance	0.028554	Model	0.023078
		Communication technologies	0.000000	Technology	0.031840	Human resource development	0.027951	Case study	0.021686
		Complementari-ties	0.000000	Cloud computing	0.031653	Simulation	0.027418	China	0.021160
		Continuous improvement	0.000000	AHP	0.030950	Job satisfaction	0.027656	Data mining	0.020979
		Culture	0.000000	Information technology	0.025619	Information security	0.027223	Decision making	0.020128

mediary. "E-HRM", "HR practices" and "performance" are the top-three keywords in terms of betweenness centrality value in general for the past 20 years in the HR-associated articles. "HRM" is the only keyword that appears in all periods, according to an assessment of the increasing and decreasing trends between the periods. Meanwhile, the "HR Practices" keyword appears in all periods except 2001–2005. "Performance" ranks among the top in terms of the betweenness centrality value for the 2006–2010 and 2016–2020 periods, as well as all other years. "Information technology", "e-HRM" and "cloud computing" keywords displayed an increasing trend between the periods.

Scientific maps. The keywords that are stated in a scientific article are considered to be connected to each other [Chen et al., 2016]. Therefore, keywords are the analysis unit in the co-word analysis [Aria, Cuccurullo, 2017; Köseoğlu et al., 2016a; 2016b]. The use of network visualization/mapping is one of the methods employed in co-word analysis of a concept. Consequently, this part provides a co-word structure visualization, which completes the network indicators that were presented in previous sections. There are two important factors in visualization. These are the high number of lines between the keywords and the size of the node that represents the keyword. The lines show the number of connections of the keywords, while the size of the nodes indicates the centrality of the keyword in the network [Uyar et al., 2020]. The bigger

the node size, the more connections it will have with the other nodes around it. All of the visualizations were done by using VOSviewer, a bibliometric network visualization software tool. VOSviewer is a computer program that is specially designed to create and visualize large maps of scientific knowledge [García-Lillo, Úbeda-García, Marco-Lajara, 2017].

The visualization comprises the clusters created by the keywords and the fading and emerging themes in the HR research field for 20 years between 2001 and 2020.

Fig. 3 shows the concept map for the 20-year period. The visualization limited with a keyword should have been used at least five times to allow for clearer examination of the keywords that appear on the map and better monitoring of the dominant keywords. The keywords examined in this period were divided into five clusters. The keywords in the red cluster include "AHP," "HRM practices," "human resource management," "job satisfaction," "knowledge management" and "organizational management." The keywords in the green cluster include "cloud computing," "employees," "human resource," "knowledge sharing" and "motivation." The keywords in the blue cluster include "human capital," "human resource development," "information technology" and "performance." The keywords in the yellow cluster include "data mining," "genetic algorithm" and "human resource allocation." The keywords in the purple cluster include "supply chain management" and "training."
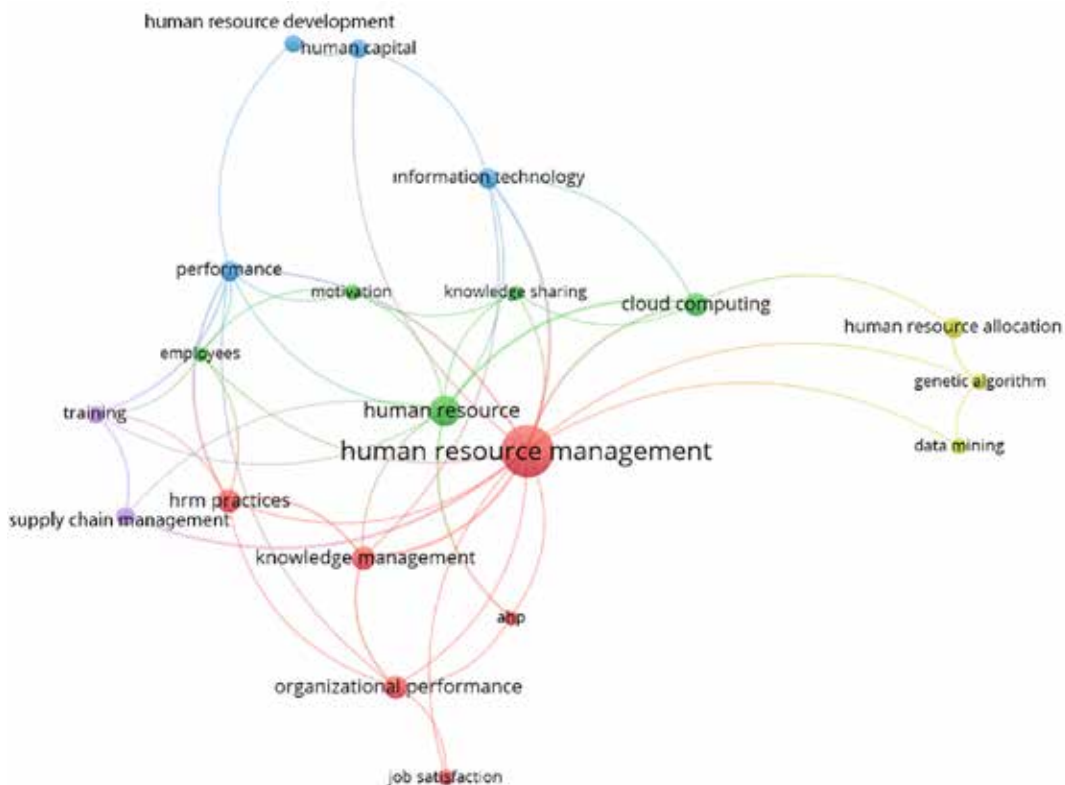

Fig. 3. Concept map of HRM keywords in the 2001–2020 period

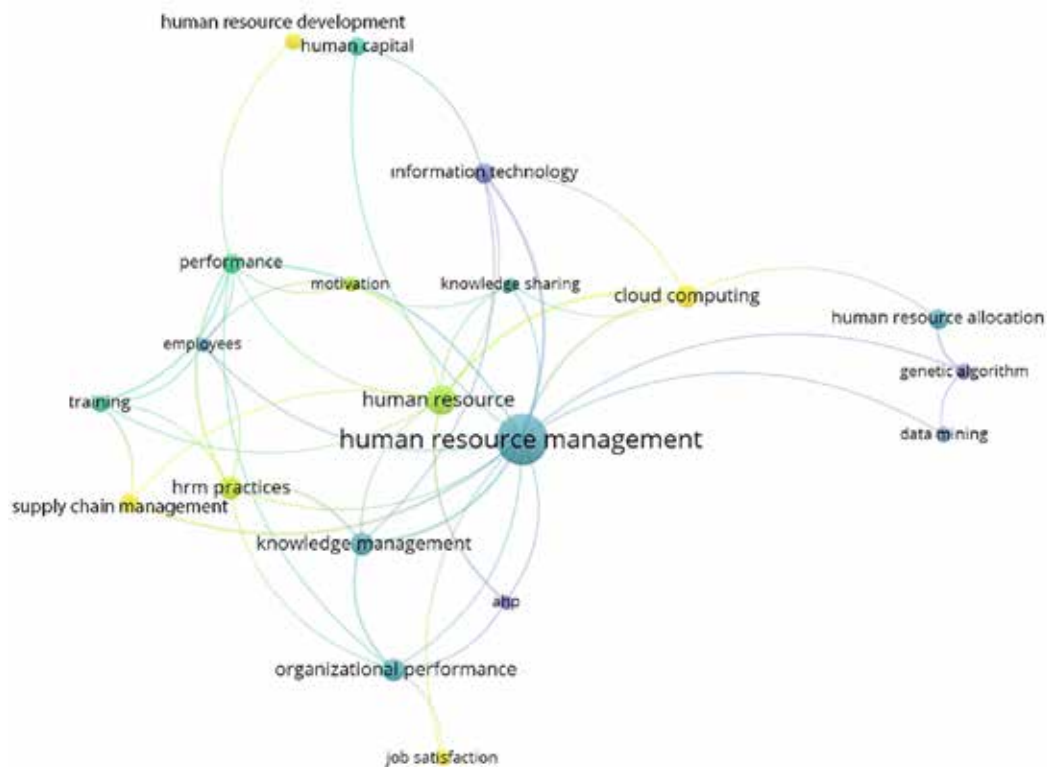***Рис. 3. Концептуальная карта ключевых слов в области УЧР за период 2001–2020 гг.***

Fig. 4. Map of the main and emerging research themes in HRM
Рис. 4. Карта актуальных и новых тем исследований в области УЧР

Fig. 4 presents the concept map that shows the main research areas and emerging themes in the 2001–2020 period. The map visualization presents the keywords that have been used at least five times. In the map, the keywords move from "purple," "green" and "yellow" in parallel with the years. Accordingly, main research areas in the HR field appear in "purple," while the emerging (the most current and highly studied ones in the HR field) subjects are in the "yellow" cluster. The green colour represents the transition subject.

As seen in Fig. 4, "AHP," "information technology," "data mining" and "genetic algorithm" keywords are the main research subjects in the HR-associated articles published in IT journals. These keywords have relatively lost their value in comparison to those in the yellow colour. "Cloud computing," "job satisfaction," "supply chain management" and "human resource development" are the most current and highly studied keywords (themes) in the HR field. Therefore, the natural conclusion is that the HR studies on IT journals would be on these themes.

DISCUSSION AND CONCLUSION
The research focused on HRM articles in IT journals by examining the past 20 years in four 5-year periods to identify the changes and evolution in this field. The research was based on 562 articles. In recent years, bibliometric studies have examined different fields [Pellegrini et al., 2020; Vošner et al., 2017]. Iwami et al. [2020] suggest that some academic fields co-evolve and grow together. This research makes it possible to explore the co-evolution be-

tween the two main fields by investigating the HR studies from an IT perspective.

According to the SNA, both average degree and connectedness values have increased each period, while the fragmentation value has decreased based on the values regarding the network of the keywords on HR studies in the IT field. This shows that the network is becoming more cohesive. The network's lower density value each period may be interpreted negatively; however, this could be explained by the higher number of components that are described as disconnected sub-groups in the network. In other words, there are new research areas in the fields. The growing number of studies generally results in an increase in the number of disconnected sub-groups in academic fields. The largest component has gradually improved in comparison to the entire network for the periods, making up 79 % of the entire network, and includes all the years. This is an indication that HRM studies in the IT field are tending to create their distinctive field. The current trends in the average degree, connectedness and fragmentation values provide that HRM studies in the IT field are on the way to creating an academic field and that the current network is tight and cohesive [Kılıç, Uyar, Koseoglu, 2019; Varga, 2011].

The ranking of the HRM and HR practices keywords are on par with their frequency, according to the keyword degree centrality assessment. Due to the fact that the database review in the research was done with the related keywords, it may be considered normal that these two concepts rank at the top in both frequency and de-

gree centrality. "Job satisfaction" is another keyword that stands out in this context. This keyword ranks among the top in terms usage frequency but ranks third with regard to degree centrality value. It means that the "job satisfaction" keyword has been used relationally along with other subjects rather than being used by itself in HRM articles [Elmortada et al., 2019; Mira et al., 2020].

"Information technology" and "artificial intelligence" are the other keywords that draw attention. The usage frequency and degree centrality ranking of the "information technology" keyword appear on par with each other. In other words, "information technology" has been specifically used in the HRM field as well as being researched along with other keywords. Literature review is revealed that "information technology" practices increase HR efficiency [Guliyeva, Rzayev, Abdulova, 2020], innovation performance, competitive edge [Waheed et al., 2020], profitability and consistency [Chen, Lin, Huang, 2015]. "Artificial intelligence," another keyword, is not ranked among the top frequency in HRM articles, but it is increasing in terms of degree centrality. Data collection and processing technologies have advanced with the use of artificial intelligence by organizations. As a result, more organizations apply it in their management processes and practices such as logistics, sales, and human resources. Nawaz [2020] asserts that artificial intelligence practices may be employed for productivity and efficiency in HRM functions to meet customer requirements.

E-HRM, AI and cloud computing keywords are on an upward trend by period, according to betweenness centrality values. These findings show that the relevant keywords are used in conjunction with the other subjects in their representative fields. The betweenness centrality value of these keywords proves to be high in all of the years, which means that the HR field is being studied along with information technologies. When evaluated along with degree centrality, the keywords with a generally high degree centrality value also have a high betweenness centrality value. This finding indicates that the network created from HR studies in the IT field is cohesive and growing through related subjects [Kılıç et al., 2019; Varga, 2011]. This result is in parallel with the findings regarding average degree, connectedness and fragmentation values. However, the low betweenness centrality value of training and business intelligence keywords may be an indication that these concepts are not sufficiently studied with other concepts.

The practical contributions of this research for managers are that it gives clues that the scientific progress towards the relationship between human resources management and IT will be within the scope of "cloud computing" and "job satisfaction" (see Fig. 4). According to the findings of bibliometric studies, managers can make the right decisions for their organizations by following these tips [Köseoglu et al., 2016]. This research also has theoretical contributions. The most important of these is

that it is the first research to examine the relationship between two different fields, "information technology" and "human resources management", with the bibliometric method. There are bibliometric studies on the relationship between two different fields in recent years [Kulakli, Osmanaj, 2020; Gupta et al., 2021; Phillips, Ozogul, 2020]. In addition, many researchers in the field of management and organization are familiar with social network analysis, but studies with this methodology are not common [Koseoglu et al., 2016a, 2016b]. In this respect, the research makes a unique contribution to the development of the literature in terms of method by jointly using "information technology" and "HRM".

IT and HRM fields are considered "far apart areas of research, incompatible underlying assumption" as stated in Okhuysen and Bonardi [2011, p. 10]. According to the authors, in order to make a theoretical contribution by associating these two fields, one must take place within the other. In this context, in modern organizations, HR activities are carried out through IT applications. When the relationship between these two fields is examined through the bibliometric method, the concept of "cloud computing" comes to the fore, especially in Fig. 4. As mentioned above, "cloud computing" is the most up-to-date subject explored in the scientific map built on the combination of the two fields.

Future directions. According to the research findings, HR development, cloud computing, supply chain management, and job satisfaction are the themes that are likely to come to prominence in the future.

With increasing demand for talented supply chain managers, HRM has become a crucial priority for organizations in supply chain management [Hohenstein, Feisel, Hartmann, 2014]. HRM plays an important role in the success of organizations' supply chain management strategy [McAfee, Glassman, Honeycutt, 2002]. There have been many studies that focus on the relationship between the IT and Supply Chain Management (SCM) fields [Shahzad et al., 2020; Han, Wang, Naim, 2017; Tseng, Wu, Nguye, 2011; Fasanghari, 2008; Lai, Wong, Cheng, 2006]. It is likely that there will be more studies from different aspects of this relationship, looking into the direct effect that HRM has on SCM. The concept map shows the training concept along with the SCM in the same cluster, which indicates the importance of training SC managers in the IT field and places emphasis on future studies in this field.

It is possible to state that IT employees are at the focal point of HRM studies in the IT field. HRM practices have a positive relationship with employee job satisfaction as per the literature studies [Davidescu et al., 2020; Mudor, 2011; Georgellis et al., 2008]. A high employee satisfaction rate helps organizations achieve their objectives [Maimako, Bambale, 2016]. The increasing interest in the concept could be explained by the fact that it bolsters higher revenues in the organization, increases production and customer satisfaction, decreases recruitment and selection

costs, lowers training costs, and improves teamwork [Hassan et al., 2013; Jeet, Sayeeduzzafar, 2014]. Organizational behaviour themes like satisfaction are bound to become gradually more important for IT employees in HRM studies.

Human resource development (HRD) remains in the same cluster as performance, information technology and human capital, which is meaningful as it represents continuous improvement that strives to improve the performance of the organization's employees. This is the consequence of HRD's direct relationship to subjects such as technology, economy, financial matters, globalization, equal opportunity, and the changing structure and organization of business [Torraco, Lundgren, 2020]. The IT infrastructure should be used effectively for HRD to be efficient in organizations [Russ-Eft, 2014]. Furthermore, the IT field is likely to lead to new ways that will help improve HRD [Bada, Madon, 2006]. Therefore, it will become important to conduct future research on the relationship between HRD and IT.

Cloud computing and associated technologies improve institutions' organizational agility and innovation capability [Reis et al., 2018]. Some research put forward that cloud computing infrastructure is needed for HRM practices in organizations [Wang et al., 2016]. Cloud computing allows organizations to complete HRM tasks effectively and reduce communication costs while improving management efficiency [Lv et al., 2018]. In this context, the research shows that the cloud computing concept will become prominent in HRM studies in the IT field in the future, which could be interpreted as a result of the efforts by companies to gain a competitive edge.

Limitations. The research used Scopus because it is a frequently preferred database in similar studies and it is a comprehensive database. This may cause studies not listed on Scopus to be excluded in this research. Future studies may include the ISI Web of Science and similar reliable databases in the research. To obtain more valid and reliable results, only journal articles were used within the scope of the database. Therefore, future studies may include other types of publications, such as book chapters and conference papers, to capture a more holistic perspective. The co-word analysis method was used in line with the research objectives. It is recommended that future research should be based on co-authorship, citation or co-citation analyses to determine the author patterns and the source of the fields. ∎

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