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## HUMAN RESOURCE MANAGEMENT PRACTICES IN BANKING: A PRISMA-COMPLIANT LITERATURE REVIEW OF DATA ENVELOPMENT ANALYSIS (DEA) APPLICATIONS

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**Abstract:** Data Envelopment Analysis (DEA) is currently the leading and most commonly applied non-parametric methodology for efficiency evaluation of banks. Considering its ever-growing popularity since its introduction in 1978, this study gives a systematic review of the scholarly literature on the topic focusing on human resource management (HRM) in the banking industry. The main purpose of this PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) - compliant literature review is to survey and identify relevant published studies in the global renowned scientific databases Scopus and Web of Science regarding the application of Data Envelopment Analysis (DEA) in banking HR (human resources) to gain state-of-the-art of the models and applications used in this research field as well as summarize the most relevant findings. The study therefore provides a summary of different DEA applications in the field of banking HR by browsing the electronic scientific databases (Scopus and Web of Science) with the keywords „DATA ENVELOPMENT ANALYSIS“/ „DEA“, „HUMAN RESOURCES“ and „BANK“/“BANKING“. Consequently, the selected relevant published papers have been classified by author name, year of publication, DEA methodology used, application area, country, scope, study purpose, contribution and implications, findings, and journals and conferences in which they were published. The findings reveal that in spite of the prominent role of HR globally as well as the popularity of the DEA method in many industries and research areas, their application in HR in the banking industry is still very low and such studies are scarce. Thus, this PRISMA-compliant literature review could represent a stepping stone and first step into the direction of implementation of DEA in the field of HR in banking and HR in general.

**Keywords:** Data Envelopment Analysis, DEA, banking, human resources, literature review, PRISMA guidelines.

### 1. INTRODUCTION

Commercial banks play crucial roles in an economy's financial system (An et al., 2019) and they represent "the economic backbone and heart of the financial system of a nation" (Salman et al., 2022) and thus, have an important role in the overall stability of the financial system, and this is especially highlighted in developing countries, where the financial system is 'bank-based' (Fotova Čiković & Cvetkoska, 2022). Moreover, banks' business model has "serious consequences for the stability of banks" (Rizwan et al., 2021) and due to this fact, their operational efficiency is very commonly investigated by scholars and practitioners from around the world.

Efficiency in banking has been "a widely researched area" (Mukherjee et al., 2003). The efficiency and performance of a banking system can be evaluated and investigated in two basic ways: with the stochastic frontier analysis (SFA) and the data envelopment analysis (DEA). The main difference between the two methodologies is that the SFA is parametric, whereas the DEA is a non-parametric methodology. Moreover, SFA "considers the impact of random factors on output", whereas DEA is a mathematical programming technique that includes multiple inputs and outputs (An et al., 2019). In this study, the authors focused on studies published regarding human resources (HR) and human resource management (HRM) in banking, with the application of the leading non-parametric methodology (DEA).

Human resources remain the most vital resource of organizations worldwide, considering the volatile, uncertain and ambiguous business environment, the increased digitalisation and global competition in a globalized world. Moreover, organizations can thrive only when applying effective human resource management (Sultana & Johari, 2023) and employees and their competencies in particular are "the most vital asset of an organization" and the key source of a sustainable competitive advantage of an organization (Salman et al., 2022).

The aim of this study is to survey and identify relevant published studies in the electronic databases Scopus and Web of Science regarding the application of Data Envelopment Analysis (DEA) in banking HR (human resources) to gain state-of-the-art models and applications used in this research field as well as summarize the most relevant findings.

This is conducted through a systematic PRISMA-compliant literature review that was initiated with the exploration of the two databases with the keywords „DATA ENVELOPMENT ANALYSIS“, „HUMAN RESOURCES“ and „BANK“/“BANKING“.

The article is divided into five main sections. Following the introduction, Section two offers a theoretical background to the DEA (Data Envelopment Analysis) methodology and the human resource practices and HRM in the banking industry. Section three outlines the chosen methodology and reveals the research design and the four steps of the PRISMA guidelines. Section four presents the research results and provides a more qualitative analysis of their models and findings. The last, fifth Section opens up a discussion and concluding remarks regarding the surveyed papers and concludes the paper, addressing the research contribution, limitations, and plans for future work.

### **Theoretical background**

Data Envelopment Analysis (DEA)

The DEA methodology has been introduced in 1978 in the seminal paper of Charnes, Cooper and Rhodes („Measuring the efficiency of decision-making units“, published in the *European Journal of Operational Research*), but was based on the previous work of Farrell (1957). Namely, they further extended Farrell’s viewpoint (approach) and provided a model that was able to measure efficiency with multiple input and output variables (Jelodar, 2016). And despite the fact it was primarily developed and introduced for use by non-profit organizations, its wide application “has surpassed other non-parametric methodologies and is now one of the leading and most popular non-parametric methodologies” used in the empirical assessment of the relative efficiency of financial institutions, health and education sectors and many other sectors (Fotova Čiković, Keček & Lozić, 2022). Moreover, this technique is often the preferred method used in researching banking efficiency, especially when banking sectors are relatively small (Sufian, 2010).

DEA is a data-oriented, operational research-based mathematical programming technique that is used to evaluate and assess the performance and relative efficiency of „complex homogeneous entities” called Decision-Making Units (DMUs), that use the same input and output variables (Cvetkoska et al., 2021; Fotova Čiković et al., 2022; Mukherjee et al., 2003).

DEA methodology is a “useful tool for the performance evaluation of decision-making units in the management science which calculates the efficiency of each decision-making unit” (Jelodar, 2016). Its wide application and popularity among scholars, practitioners and academic members is praiseworthy, and it is due to its simplicity to use and the option to involve multiple inputs and outputs at the same time.

Human resources in banking

Banks have traditionally focused on and explored what causes the efficient use of their physical resources and they “inadvertently ignored the mediating intangible factor of service quality” (Mukherjee et al., 2003). Moreover, for decades, banks have merely paid attention to the financial indicators as if they were the only determinant factor for banking systems evaluation (Azadeh et al., 2015).

However, it is a very well-known fact nowadays that the key to success in the banking industry is influenced by two vital challenges (namely, the management of people and the management of risk) (Testa et al., 2022). Intellectual capital is today seen as the „key to opening doors for banks to achieve competitiveness” and as a main source of intangible assets, that drives “competitive advantage and sustainable development of organisations in the medium and long term” (Van Nguyen & Lu, 2023). This is an area that has been slightly neglected thus far, but the focus is currently set on intellectual capital and its importance in banking as well as any other sector.

## **2. RESEARCH DESIGN**

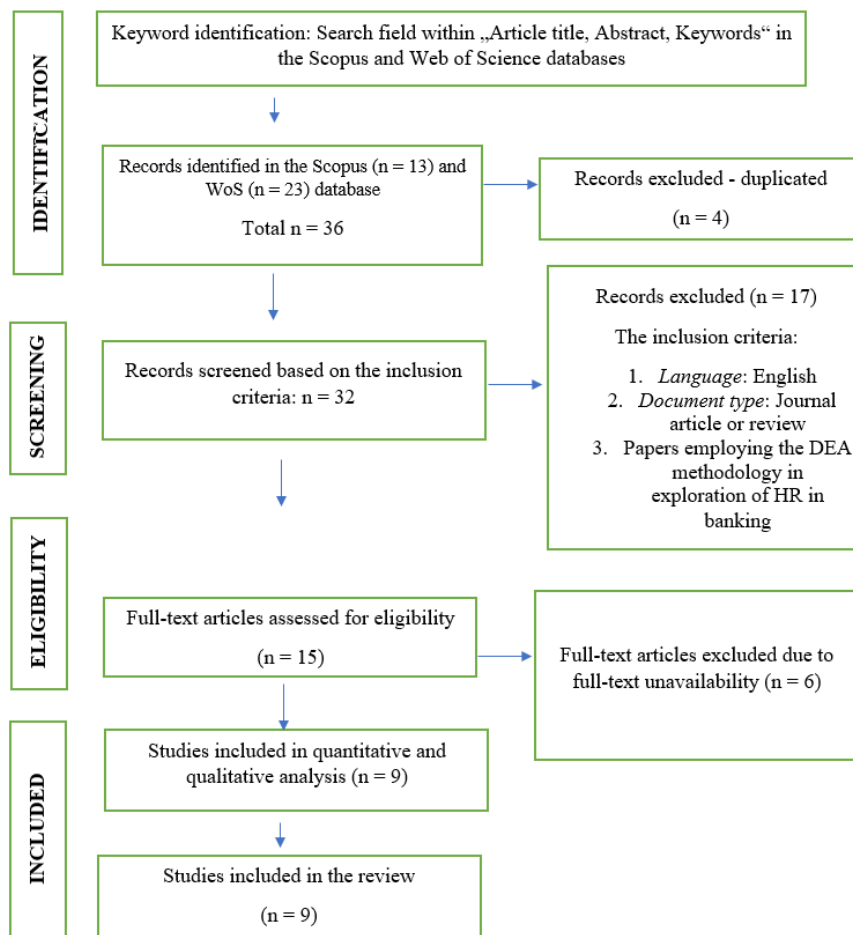
The systematic literature review (SLR) is the methodology used for this study. It is a rather dominant methodology used to summarize past findings in a research field and is referred to as an “essential tool for summarizing evidence accurately and reliably” (Liberati et al., 2009). However, it is mostly applied to medical research and not so commonly to social sciences. Therefore, this study also gives new insights into the use of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines in social sciences. The PRISMA guidelines were introduced in 2009 by Moher et al. (2009), they follow a 27-item checklist and a “four-phase flow diagram” and its main objective is to “help authors improve the reporting of systematic reviews and meta-analyses” (Moher et al., 2009; Fotova Čiković et al., 2022).

The systematic literature review following the PRISMA guidelines is presented in Figure 1. The review consists of four stages as follows: the identification, the screening, the eligibility and the inclusion stage. Several steps were applied in each of these stages, in accordance with the PRISMA guidelines and the inclusion and exclusion criteria. In the first stage of identification, the two databases were explored with the keywords „DATA ENVELOPMENT ANALYSIS“, „HUMAN RESOURCES“ and „BANK“/“BANKING“. This resulted in 13 papers in the Scopus

database and 23 papers in the Web of Science database, i.e. a total of 36 papers. Four of these papers were excluded due to duplication. There were 32 papers entering the second stage of screening. In this step, the identified studies were screened based on the inclusion criteria (i.e. the English language, document type – Journal article or review and the subject researched – DEA in banking HR and HRM) and the fully downloadable papers have been identified. Moreover, no publication period has been pre-set, which means all the published articles since the introduction of DEA in 1978 were included. Fifteen papers entered the eligibility stage, where a full-text manual screening was applied and 6 papers were excluded. Therefore, a total of 9 papers entered the stage of inclusion and were furthermore qualitatively assessed and presented by this study.

The main goal of this review was to survey the most relevant scientific databases (i.e. Scopus and Web of Science) in systemizing the previous relevant published work regarding the application of DEA in HR and HRM in banking. The research approach and the results reveal the DEA methodology, even though very popular in banking, is insufficiently and very modestly applied to human resources and human resources management-related research.

**Figure 1. The PRISMA-compliant review of studies on human resources management in banking with the application of Data Envelopment Analysis (DEA).**



SOURCE: Authors' work.

In the next Section, a more detailed and qualitative presentation of the surveyed studies will be presented and a discussion of their findings follows thereafter.

### 3. RESEARCH RESULTS

In the banking literature, scholars have mainly focused on the efficiency and performance of the banks in the context of their operations, and this is the main reason why Emrouznejad & Yang (2018) found that banking is one of the fields where DEA is mostly applied to (along with the supply chain, public sector, agriculture and transportation

industry). However, scholars and researchers employing DEA have neglected the issue of HR and HRM in banking in general. This is backed up by the fact that the initiated research resulted in a total of 9 relevant published papers regarding HR and HRM in banking with the application of DEA, with no constraints of time of publication. A tabular overview of the surveyed papers is given in Table 1 and a more detailed and qualitative presentation of their methodologies, DEA models as well as their findings and contributions are given thereafter.

**Table 1. Surveyed papers regarding HR and HRM with the application of DEA (Authors, Title of paper, Methodology, Country, Type of paper and Publication).**

<i>Authors</i>	<i>Title of paper</i>	<i>Methodology</i>	<i>Country</i>	<i>Type of paper</i>	<i>Published in</i>
<b><i>Mukherjee, Nath &amp; Pal (2003)</i></b>	Resource, service quality and performance triad: a framework for measuring efficiency of banking services	Output-oriented BCC DEA in a combination with SERVQUAL method	India	Journal article	<i>Journal of the Operational Research Society</i> 54
<b><i>Azadeh, Ghaderi, Mirjalili, Moghaddam &amp; Haghghi (2015)</i></b>	Optimization of Human Resources and Industrial Banks with Ambiguous Inputs Using Intelligent Fuzzy Mathematical Programming Approach	An integrated fuzzy data envelopment analysis (FDEA) and analytical hierarchy process (AHP)	n.a.	Journal article	<i>Journal of Scientific &amp; Industrial Research</i> , 74
<b><i>Jelodar (2016)</i></b>	Prioritization of the Factors Affecting Bank Efficiency Using Combined Data Envelopment Analysis and Analytical Hierarchy Process Methods	A combined DEA/AHP method - DEAHP Method	Iran	Journal article	<i>Hindawi Publishing Corporation Journal of Optimization</i>
<b><i>An, Liu, Li &amp; Xiong (2019)</i></b>	Resource planning of Chinese commercial banking systems using two-stage inverse data envelopment analysis with undesirable outputs	Two-stage inverse DEA with undesirable outputs	China	Journal article	<i>PLoS ONE</i> 14 (6)
<b><i>Ting, Ren, Chen &amp; Kweh (2020)</i></b>	Interpreting the dynamic performance effect of intellectual capital through a value-added based perspective	DEA + value-added intellectual coefficient (VAIC™)	Taiwan	Journal article	<i>Journal of Intellectual Capital</i>
<b><i>Nepomuceno, de Carvalho &amp; Costa (2020)</i></b>	Time-Series Directional Efficiency for Knowledge Benchmarking in Service Organizations	DEA output-oriented model under the VRS assumption	Brazil	Book chapter	<i>Springer, WorldCIST 2020, AISC 1159</i>

<b>Ting, Chen, Kweh, Sui &amp; Le (2021)</b>	Intellectual capital and bank branches' efficiency: an integrated study	DEA models (BCC, EBM and BootBCC)	Taiwan	Journal article	<i>Journal of Intellectual Capital</i>
<b>Nepomuceno, de Carvalho, Nepomuceno &amp; Costa (2022)</b>	Exploring knowledge benchmarking using time-series directional distance functions and bibliometrics	Data Envelopment Analysis' DDF formulation	Brazil	Review	<i>Expert Systems</i>
<b>Tiwari, Vidyarathi &amp; Kumar (2023)</b>	Nexus between Intellectual Capital and Bank Productivity in India	The Malmquist Productivity Index, the Data Envelopment Analysis and the Value-Added Intellectual Coefficients model framework	India	Journal article	<i>Journal of Risk and Financial Management 16</i>

SOURCE: Authors' work.

**Mukherjee, Nath & Pal (2003)** have developed a theoretical framework for evaluation of the efficiency of banking services “taking into account physical and human resources, service quality and performance” and thus, linked the marketing variables to the financial metrics, with the application of a combination of the DEA and SERVQUAL methodologies. Their paper is among the first papers employing DEA in the HR-related research field. Their sample consists of 27 Indian public sector banks. They employ the output-oriented BCC DEA model in the second stage of their study and furthermore employ the modified DEA model for measuring efficiency in the combined stage. They have tackled the interconnectedness between resources, service quality and performance for services and their findings reveal that banks focused on delivering better service have experienced “better transformation of resource to performance using superior service delivery as the medium”. This is the first empirical study to involve human resources, service quality and performance all at once.

**Azadeh, Ghaderi, Mirjalili, Moghaddam & Haghghi (2015)** present a rather groundbreaking paper that employs an “integrated fuzzy data envelopment analysis (FDEA) and analytical hierarchy process (AHP) approach” for optimization and ranking of industrial banks with ambiguous human resources indicators. They categorized eight major qualitative indicators for human resources operations as follows: skills and capabilities; work quality; responsibility; innovation and creativity; incentives and motivations; relations; discipline; and operations of human resources. In the process of results validation, they have employed mathematical models and their study is the first study that employs the integrated FDEA-AHP method for industrial banks. Their proposed FDEA method represents “a superior approach for dealing with the uncertainty of the qualitative indicators because of its high degree of correlation with DEA”.

**Jelodar (2016)** employed a combination of the DEA and the AHP (Analytical Hierarchy Process) methodology, i.e. DEAHP method to provide an answer to the question of which of the factors affect performance, creating value, and increasing shareholder dividends are superior in banks. The author encompassed 28 vital factors affecting banks' performance in the area of „management, personnel, finance, and customers” and thereafter applied the AHP to prioritize the factors and weights that were calculated from the paired comparisons were run with the combined DEAHP methodology. The findings reveal that “the leadership style in the area of management; the recruitment and resource allocation in the area of financing; the employees' satisfaction, dignity, and self-actualization in the area of employees; and meeting the new needs of customers” resulted in more weights and therefore, are superior to other factors and management should pay more attention to them.

**An, Liu, Li & Xiong (2019)** examine and focus on resource planning for 16 Chinese listed banks with the employment of a two-stage inverse DEA model that considers both the changes in desirable and undesirable outputs. Their findings reveal new insights into how banks or similar organizations could benefit from formulating temporary resource plans in the short term and could be of great benefit to managers. Moreover, they found that “operation cost

and interest expense are more flexible than labor in the adjustment process and that deposits have no obvious law of change”.

**Ting, Ren, Chen & Kweh (2020)** tackle the issue of whether intellectual capital (IC) is beneficial to firm performance or not. The study revolves around the effect of changes in IC to the performance and this study includes banks and other Taiwanese electronics companies in the period from 2006 – 2017. The Data envelopment analysis methodology is combined with the value-added intellectual coefficient (VAIC™) to evaluate the IC and its components, namely human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE). Their findings reveal that „IC efficiency and CEE significantly and negatively affect firm performance, thereby suggesting a contradictory common sense with the resource-based view on the beneficial effects of IC”. Moreover, it suggests that managers should consistently focus on IC adjustment, especially human capital (HC) for better decisions that help grow performance.

**Nepomuceno, de Carvalho & Costa (2020)** applied the output-oriented VRS DEA model to one branch unit of the Brazilian Federal Saving Bank (Caixa Econômica Federal - CEF) in the period from July 2016 to June 2019. The input variable for the DEA model is the number of employees, whereas the output variable is the business block of “Business Block and Social Programs and Teller Services Block”. Thus, this study provides an internal benchmarking of efficient time frames “of which innovative processes, competitive strategies, human resource changes, and specific incentive structures were adopted”. This study contributes to the scholarly literature since it allows for “designing new knowledge management strategies, process innovations, planning and control the performance of human resources according to the seasonality and specific environmental aspects of the business”.

**Ting, Chen, Kweh, Sui & Le (2021)** explore the association between intellectual capital (IC), i.e. the three components of IC (HC - Human Capital, SC – structural capital, and RC - Relationship Capital) and bank efficiency of Taiwanese bank branches in 2018. They employ the three structural model estimations – DEA BCC, EBM and BootBCC to gain new insights into the bank branches of Taiwan Business Bank Company Limited. Their study is based on the RBV (Resource-based view) theory. Their study is revolutionary since it is the first empirical study to integrate both “primary and secondary data to examine the association between IC and bank efficiency of Taiwanese bank branches”. Their findings reveal that “relational capital (RC) significantly and negatively impacts bank efficiency”, whereas human capital (HC) and structural capital (SC) do not contribute to bank efficiency in Taiwan.

**Nepomuceno, de Carvalho, Nepomuceno & Costa (2022)** based their work on Nepomuceno et al. (2020) and extended the work of Nepomuceno et al. (2020c) with the proposal of a “partially automated methodology that combines the Time-series Directional Efficiency Analysis of DEA with Human Interactive interviews and Bibliometric Couplings for the benchmarking of best practices and strategic knowledge investigation in the service units”, on the case study of a branch of Caixa Econômica Federal, the Brazilian Government Federal Savings Bank. The main aim of the study is to employ internal benchmarking, with the use of “bibliometric coupling on semantic strategies from different personnel perspectives, creating a semantic network to identify the best-related strategies, and prioritizing the statement stream”.

**Tiwari, Vidyarthi & Kumar (2023)** have investigated the impact of intellectual capital on changes in total factor productivity of 36 BSE-listed banks in India in the period from 2005 to 2019. They perform a two-stage analysis and combine the Malmquist Productivity Index, the Data Envelopment Analysis and the Value-Added Intellectual Coefficients model framework, i.e. a DEA-based MPI approach and a VAIC/MVAIC model framework. Interestingly, they found productivity growth to be “primarily driven by efficiency changes rather than technological changes” and intellectual capital to have “a strong favourable impact on total factor productivity and its sub-components in the Indian banking sector”. This study provides new insights and is among the very few empirical studies regarding Indian banking that examine “the nexus between intellectual capital and productivity using the Malmquist Productivity Index”.

#### 4. DISCUSSION AND CONCLUSION

Even though the DEA methodology has been introduced over 40 years ago, most of the surveyed nine papers have been published after 2015, which reflects the scarcity of empirical studies in the area of HRM with the application of DEA. Only one paper (Mukherjee et al., 2003) has been published in 2003. There are two published studies only in the year 2020. This is somewhat in line with the authors’ expectations and it once more reveals the motivation and objective of this study: to inspire other scholars to employ the DEA methodology in HR-related research in the future. These findings indicate that, despite the prominent role of human resources globally as well as the popularity of DEA methodology in many industries, their application in HR in the banking industry is quite modest.

Most of these papers (i.e. 8 out of 9 papers) are papers published in a journal. A complete tabular list of the type of papers as well as the source is given in Table 1.

Moreover, two of the surveyed papers (Ting et al.,2020 and Ting et al.,2021) have been published in the I Journal of Intellectual Capital. Thus, this study has identified the venues that publish studies regarding HR and HRM in banking with the application of DEA.

In addition to this research, an analysis of the most contributing authors on this subject has been conducted. Namely, authors Ting, Nepomuceno, Chen, Kweh, de Carvalho and Costa (with 2 published papers) have mostly contributed the scholarly literature in this research area.

As for the application area & scope, study purpose, contribution and implications and findings, a summary of their most crucial findings is given in Table 2 below.

**Table 2. Application area & scope, study purpose, contribution and implications and findings of the surveyed papers.**

<i>Authors</i>	<i>Application area &amp; scope</i>	<i>Study purpose</i>	<i>Contribution and implications</i>	<i>Findings</i>
<b><i>Mukherjee, Nath &amp; Pal (2003)</i></b>	Linking the marketing variables to the financial metrics of banks	Development of a theoretical framework for evaluation of the efficiency of banking services “taking into account physical and human resources, service quality and performance”	First paper employing DEA in the HR-related research field	Banks focused on delivering better service have experienced “better transformation of resource to performance using superior service delivery as the medium”
<b><i>Azadeh, Ghaderi, Mirjalili, Moghaddam &amp; Haghghi (2015)</i></b>	The suggested approach of the study can be utilized for all industrial banks in order to investigate the efficiency of human resources	To optimize and rank industrial banks with ambiguous human resources indicators	The first study that presents an integrated FDEA-AHP approach for ranking and optimization of industrial banks with ambiguous human resources indicators	FDEA method represents “a superior approach for dealing with the uncertainty of the qualitative indicators because of its high degree of correlation with DEA”
<b><i>Jelodar (2016)</i></b>	Prioritization of the Factors Affecting Bank Efficiency	To provide an answer to the question of which of the factors affecting performance, creating value, and increasing shareholder dividends are superior to others	The results can be used for operational decision-making in banks	The leadership style; the recruitment and resource allocation; the employees’ satisfaction, dignity, and self-actualization; and meeting the new needs of customers” resulted in more weights

<i>An, Liu, Li &amp; Xiong (2019)</i>	Addressing the literature gap that neglects network structure analysis in inverse DEA	To examine and focus on resource planning for 16 Chinese-listed banks	New insights for bank managers	Findings on how banks or similar organizations could benefit from formulating temporary resource plans in the short term
<i>Ting, Ren, Chen &amp; Kweh (2020)</i>	Interpreting the dynamic performance effect of intellectual capital	To answer the question of whether intellectual capital (IC) is beneficial to firm performance	Managers should consistently focus on adjusting their IC, especially human capital (HC)	„IC efficiency and CEE significantly and negatively affect firm performance, thereby suggesting a contradictory common sense with the resource-based view on the beneficial effects of IC”
<i>Nepomuceno, de Carvalho &amp; Costa (2020)</i>	Time-Series Directional Efficiency for Knowledge Benchmarking in Service Organizations	To propose a time-series adaptation for directional model	The identification and aggregation of strategic knowledge that can be crucial for the business success	An internal benchmarking of efficient time frames “of which innovative processes, competitive strategies, human resource changes, and specific incentive structures were adopted”.
<i>Ting, Chen, Kweh, Sui &amp; Le (2021)</i>	The interconnectedness of intellectual capital and bank branches’ efficiency	To investigate the association between intellectual capital (IC) and bank efficiency of Taiwanese bank branches	Bank branches should focus on enhancing their service quality to attract customers	Relational capital (RC) significantly and negatively impacts bank efficiency. Human capital (HC) and structural capital (SC) do not contribute to bank efficiency.
<i>Nepomuceno, de Carvalho, Nepomuceno &amp; Costa (2022)</i>	This study's analytical scope is limited to only one bank branch	To employ internal benchmarking	Proposing a time-series formulation for the DDF efficiency model with internal benchmarks	Data Envelopment Analysis' DDF formulation can be valuable for decision-making when combined with other bibliometric or multicriteria approaches

<i>Tiwari, Vidyarthi &amp; Kumar (2023)</i>	The influence of intellectual capital on changes in total factor productivity of 36 BSE-listed banks in India	To investigate the impact of intellectual capital on changes in total factor productivity of Indian banks	It examines the nexus between intellectual capital and productivity using the Malmquist Productivity Index	Productivity growth is primarily driven by efficiency changes rather than technological changes
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SOURCE: Authors' work.

The potential use of artificial intelligence and other technological advances in HR are currently topical subjects and have opened many new opportunities for the development of a new field of HR. However, the vitality and crucial role of human resources in banking (as well as any other industry) should not be taken for granted.

The main purpose of the study was to explore the two most renowned global scientific databases (Scopus and Web of Science) and identify relevant published studies regarding the application of Data Envelopment Analysis (DEA) in banking HR (human resources) to gain state-of-the-art of the models and applications used in this research field as well as summarize the most relevant findings. This was conducted through a systematic PRISMA-compliant literature review that was initiated with the exploration of the two databases with the keywords „DATA ENVELOPMENT ANALYSIS“, „HUMAN RESOURCES“ and „BANK“/“BANKING“.

This study, however, is not without limitations. First of all, the authors surveyed only two of the global scientific databases (Scopus and Web of Science), which limits the results to only those studies published in journals and conferences that are indexed in these databases. There is a possibility that other relevant papers have been published elsewhere but have not been included in this study. Secondly, the DEA methodology itself is not without limitations (as stated in Fotova Čiković & Lozić, 2022), and, according to Azadeh et al. (2015), its main limitation is its sensitivity to the data in an uncertain environment. And lastly, the findings revealed from the systematic literature review are limited to the banking industry and cannot be generalized to other industries.

The main contribution of the study is an analysis of the DEA methods and models used and developed in the field of HR in banking. This study provides future research guidelines by identifying patterns in (1) the areas of application, (2) the used DEA models, and (3) the combination of DEA with other methodologies when analysing HR in banking. In future work, the authors will conduct empirical research regarding the efficiency of human resources in the Croatian banking sector and thus, they will enrich the already scarce and limited application of DEA in HR.

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