Védelem Tudomány 10. évfolyam 3. szám, 2025 DOI: 10.61790/vt.2025.20429

The Role of Controlling in Public Finance: A Systematic Literature Review with a Disaster Management Perspective

A kontrolling szerepe az államháztartásban: szisztematikus irodalomelemzés katasztrófavédelmi kitekintéssel

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Abstract:

The operation of the public sector today faces increasing social, economic, and security challenges, which necessitate the strengthening of budgetary management and decision-making processes. In this environment, controlling has become a key supporting tool for effective governance and the transparent use of resources. This study aims to systematically review the domestic and international literature on controlling, with particular emphasis on applications related to the central budget and public sector institutions. The thematic classification of the analysed sources (theoretical, supporting, and practical controlling) enabled the identification of the multidisciplinary nature of controlling as well as its application trends. The analysis revealed that research is increasingly shifting toward practical implementation, while theoretical frameworks and supporting systems continue to show ongoing development.

Keywords: controlling, public finance, public sector, decision support, efficiency

Absztrakt:

A közszféra működése napjainkban fokozott társadalmi, gazdasági és biztonsági kihívásokkal szembesül, amelyek a költségvetési gazdálkodás és a döntéshozatali folyamatok megerősítését teszik szükségessé. A kontrolling ebben a környezetben a hatékony irányítás és az erőforrások átlátható felhasználásának egyik meghatározó támogató eszközévé vált. A tanulmány célja a kontrollingról szóló hazai és nemzetközi szakirodalom szisztematikus feldolgozása, különös tekintettel a központi költségvetéshez és a közszféra intézményeihez kapcsolódó alkalmazásokra. A feldolgozott források tematikus csoportosítása (elméleti, támogató és gyakorlati kontrolling) lehetővé tette a kontrolling multidiszciplináris jellegének, valamint alkalmazási tendenciáinak azonosítását. Az elemzés rámutatott, hogy a kutatások súlypontja egyre inkább a gyakorlati implementáció felé tolódik, miközben az elméleti keretek és a támogató rendszerek folyamatos fejlődést mutatnak.

Kulcsszavak: kontrolling, államháztartás, közszféra, döntéstámogatás, hatékonyság

1. INTRODUCTION

The utilisation of public resources, the assurance of accountability, and the effectiveness of decision support are all factors that have a direct impact on the quality and security of public service delivery. Controlling, as a management support tool, has long played a decisive role in the corporate sector. In recent years, however, its importance has also increased in the public sector, as it can promote the optimal use of resources and support both strategic and operational decision-making. The significance of the topic is indicated by our previously published study, "**Controlling as a Possible Support Tool**" [60], which primarily examined the role of controlling in the public sector within a theoretical and methodological framework. In contrast, the present research aims to identify the primary directions of the scientific discourse, methodological development trends, and potential applications of control systems in relation to the central budget through a systematic literature review. The use of the PRISMA protocol ensured objectivity and transparency, enabling the targeted processing of relevant sources. The analysis encompassed not only the domestic but also the international publication space, with a particular emphasis on the theoretical, methodological, and practical dimensions of control. Thus, the study contributes to the scientifically grounded exploration of development opportunities embedded in the financial management of central budgetary institutions..

2. SYSTEMATIC LITERATURE REVIEW

First, a brief theoretical framework is presented to support the systematic literature review and to define the research objectives and methodology. This is followed by the presentation of the analysis results and the conclusions drawn from them.

2.1 Methodology of Systematic Literature Review

2.1.1 Theoretical Overview of Systematic Literature Review

Traditional, so-called narrative literature reviews may contain significant subjective elements, as their quality and comprehensiveness largely depend on the content of the databases used, the number of accessible sources, and the researcher's individual selection practices. Consequently, the reliability, systematisation, and reproducibility of the information incorporated into scientific work (studies, journal articles, etc.) often become uncertain. One of the basic prerequisites of scientific rigour is that the researcher must be able to identify current trends within the relevant scientific field by reviewing the literature, thereby contributing to a deeper understanding and processing of the research question under examination. To avoid distortions arising from individual interpretation, it is advisable to apply a transparent, verifiable, and fully traceable methodology. This is precisely what systematic literature searching and reviewing offer, supported by the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses**[1] protocol. The PRISMA methodology has been continuously developed based on

the input of researchers and users to ensure the inclusion of increasingly objective, critical, and research-relevant academic background. In this process, the researcher first defines the research question to be examined and then organises the collection and processing of relevant literature around it [61].

The main steps of a systematic literature review are as follows:

[1] **Preferred Reporting Items for Systematic Reviews and Meta-Analyses**: PRISMA (protocol)

a) **Identification** – Defining the research topic through keywords and conducting targeted searches in scientific bibliographic databases[2] (e.g., Google Scholar, Web of Science, PubMed, Scopus) using Boolean operators[3].

b) **Screening**[4] – Preliminary selection of studies based on title and abstract. Exclusion criteria may include differences in the research field, publication language, geographical focus, or document type.

c) **Eligibility**[4] – Screening based on the full text to determine whether the study actually relates to the research topic and meets the inclusion criteria (e.g., citation count, relevance, recency).

d) **Included** – Systematization, categorization, and further in-depth analysis of the finalized sources. Studies less relevant to the research are justifiably excluded at this stage.

The logical interrelations of steps *a) – d)* are illustrated in *Figure 3*. The systematic literature review, conducted according to the PRISMA protocol, adheres to strict methodological criteria, the details of which are summarised in *Tables 5* and *6*. The systematic processing of the selected literature base provides the foundation of scientific work and defines the methodological framework of the research. The resulting literature set most appropriately meets the requirements of a systematic literature review. [59].

2.1.2 Definition of Research Topic and Objectives

The complexity of public service tasks, as well as the quantitative and qualitative assurance of their delivery, are closely linked to external environmental factors such as migration crises, pandemic situations, energy crises, or geopolitical conflicts. As a result, the optimal use of resources, their measurement, and the provision of feedback to decision-makers become of paramount importance for the state. In the public sector, the role of data-driven information production is becoming increasingly valued, functioning in many respects similarly to practices in the business sector. Controllers in that domain increasingly rely on artificial intelligence and data science tools to provide management with accurate, timely, and decision-supportive information. Among the prerequisites for effective, efficient, and economical operation, particular significance is attributed to adequate human resource capacity, the availability of material and immaterial resources, a modern organisational structure, and a leadership approach capable of adapting to rapidly changing environments. The central focus of this research is the examination of **the controlling system within the economic domain of the central budget, as well as the exploration of its development opportunities.**

The research objectives can be summarised as follows:

a) Examination of the controlling approach and its practical application in various levels and types of financial decision-making.

b) Analysis and evaluation of the technical and information technology toolkit available for and applied in controlling activities.

[2] **Bibliographic databases**: structured collections that store bibliographic descriptions (i.e., information) of various documents such as books, articles, and studies in electronic form, often complemented with abstracts or annotations. These databases allow users to explore topics, authors, or publications in journals, thus supporting literature discovery.
[3] **Boolean operators**: words or symbols used to connect search terms, enabling the narrowing or broadening of search results. The most typical logical operators are „AND", „OR", and „NOT".
[4] **Screening and Eligibility groups**: can be merged and presented as a single combined category.

c) Investigation of the knowledge composition of the personnel involved in the implementation of controlling activities, with particular attention to the ratio of explicit (knowledge-based) and implicit (experience- and problem-solving-based) knowledge.

Thus, the research focuses on examining the controlling system, its toolkit, and its operation within the central budget, with particular emphasis on the role of controllers and the potential for system development.

2.1.3 Research Methodology

Systematic data collection and analysis were carried out through the broadest possible application of the PRISMA protocol guidelines.

Three online scientific databases were included in the study:

a) Google Scholar[5]

b) MATARKA[6]

c) Web of Science[7]

These are recognised publication sources at both national and international levels. The temporal scope of the search was limited to the last ten years (2013, second semester – 2024, first semester) to ensure timeliness. In titles, abstracts, and keywords, the following Hungarian and English search terms were applied: **központi költségvetés, költségvetés, közszféra, költségvetési kontrolling, kontrolling/controlling, budget controlling, central budget, public sector, public sector and controlling**.

The search was restricted to publications appearing in scientific journals. Additional specific filters were applied per database: in the case of Google Scholar, review articles were included, while in Web of Science, only publications belonging to the categories Business Finance, Economics, Management, and Public Administration were considered. All results were imported into **RefWorks**[8] reference management software without further refinement, ensuring accurate and systematic registration. The initial duplicate filtering (title, author, year) was also carried out using RefWorks [57], [58].

The quantification of search results is presented in *Table 1*. In total, 780 results were identified across the three databases, of which 22 duplicates were removed by RefWorks, leaving 758 unique items.

[5] **Google Scholar**: a scholarly search engine that indexes publications across disciplines and formats; it is not a peer-reviewed database. Available at: https://scholar.google.com

[6] **MATARKA**: a searchable database of the tables of contents of Hungarian journals (not a peer-reviewed database). Available at: https://matarka.hu

[7] **Web of Science**: a bibliographic database designed not to provide full-text access but to include metadata and interconnections between articles in a way that supports scientometric analyses. Available at: https://mjl.clarivate.com/search-results

[8] **RefWorks**: a cloud-based, web-based reference management software that helps researchers, students, and others collect, organise, share, and cite sources. Available at: https://refworks.proquest.com

Search keyword definition	Google Scholar	MATARKA	Web of Science	Total
központi költségvetés	59	0	0	59
költségvetés	46	148	0	194
közszféra	22	22	0	44
költségvetési kontrolling (controlling)	3	1	0	4
kontrolling (controlling)[9]	30	168	0	246
budget controlling	0	0	0	0
central budget	0	0	102	102
public sector and controlling	0	0	131	131
Total results:	**160**	**387**	**233**	**780**
Duplicates (RefWorks):	17	5	0	22
Corrected total:	**143**	**382**	**233**	**758**

Table 1: Number of sources identified based on the research topic (prepared by the authors)

The corrected source material was processed in the Covidence[10] software according to the following steps:

a) Import of references from RefWorks,

b) Further duplicate removal by Covidence,

c) Review of titles and abstracts,

d) Full-text review,

e) Extraction procedure: data extraction and quality management processes.

As a result of the screenings, from **the initial 780 results**, after multiple duplicate removals, **749 publications** remained. Following the exclusion of non-relevant studies (e.g., those focusing on marketing or macroeconomic analyses), **89 items** were selected for more detailed analysis. Among these, the full text was unavailable in 13 cases, therefore **56 publications** were ultimately deemed entirely relevant for this research.

[9] In the case of **Google Scholar**, only the keyword "kontrolling" was applied during the search.

[10] **Covidence**: a software platform that simplifies and enhances the process of preparing systematic reviews and comprehensive literature searches. Available at: https://www.covidence.org

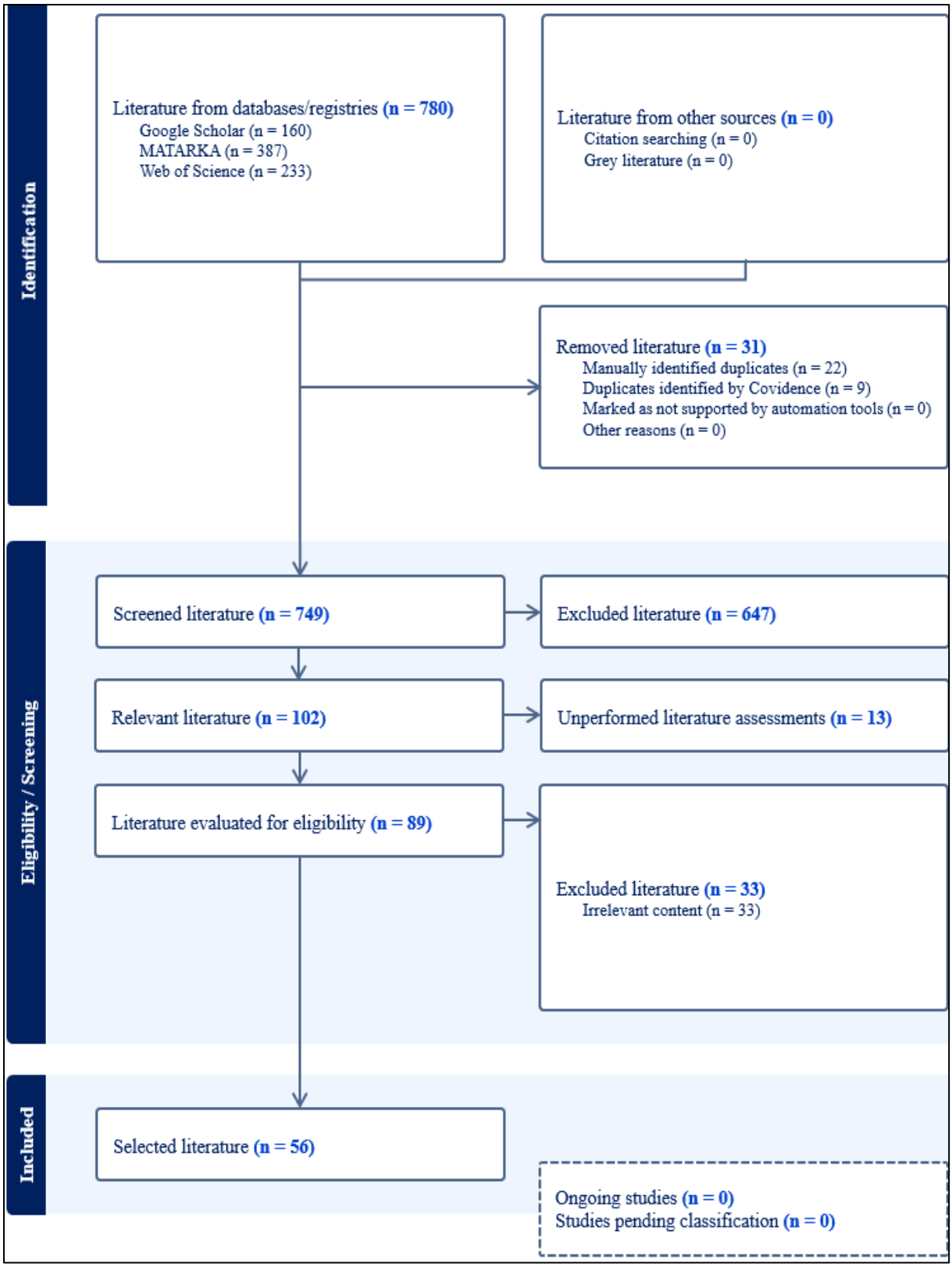

Figure 1: Flowchart of the PRISMA protocol (created by the authors using Covidence)

The selected works primarily focused on the theoretical and practical interpretation of controlling, its application in various sectors, its historical development, and modernisation trends. Journal articles were the primary emphasis of the review, with special attention to Hungarian-language literature. The thematic classification of the material resulted in three categories: **theoretical controlling**, **applied controlling**, and **supporting controlling** [57], [58].

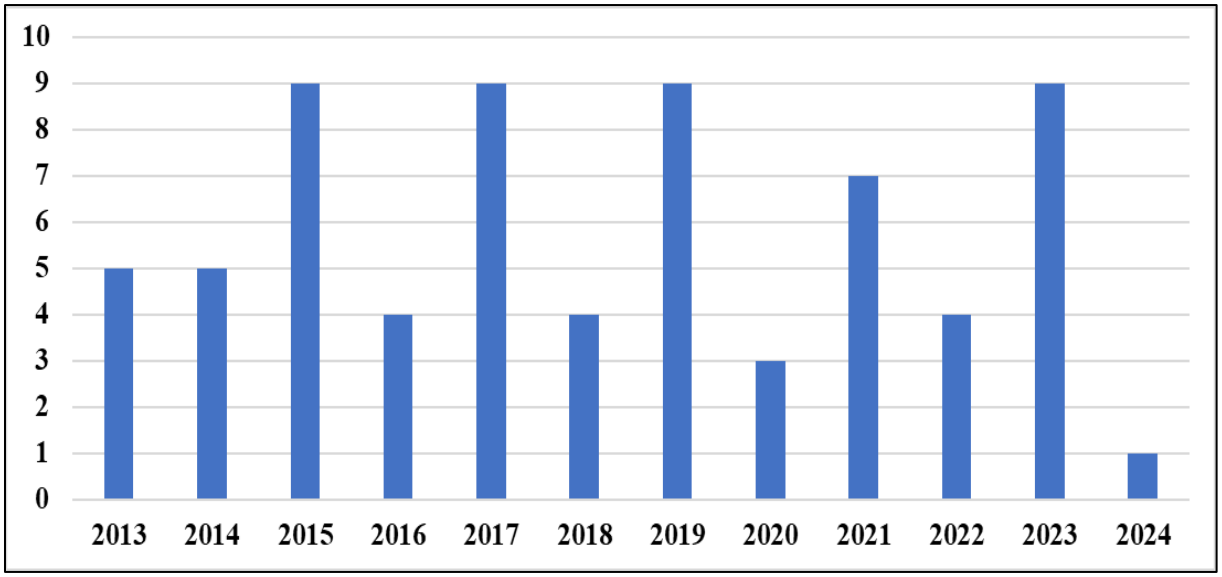

Figure 2: Distribution of selected sources by publication years (prepared by the authors)

The temporal distribution is illustrated in *Figure 2*, which shows an annual publication average of 5.75 items and a visible increase in odd-numbered years. The references of the 56 selected items were re-imported into RefWorks for further bibliographic operations and exported to the **VOSviewer**[11] visualization[12] software. This enabled the visualization of connections between authors and their publications (*Figure 4*) as well as grouping by author relationships (*Table 7*).

2.2 Results and Conclusions of the Systematic Literature Review

Between 2013 and 2024, after applying the PRISMA protocol, 56 publications ([*1*]–[*56*]) were selected. Their annual distribution is presented in *Figure 1*. The data indicate that, on average, 5.75 publications per year addressed the topic of controlling during the observed period. A cyclical pattern was evident: with minor declines occurring in even years, followed by substantial increases in odd years. This trend can be linked to global social and economic events (e.g., 2022: war in Ukraine, 2020: Covid-19 pandemic, 2018: the peak of the People's Republic of China's global economic expansion, 2016: Brexit and the election of a new U.S. president). Such impacts were most pronounced in even years, while processing and publication typically materialised in the subsequent odd year.

The thematic classification of the publications resulted in three major groups:

a) **Theoretical controlling** – conceptual development, definitional issues, organizational embeddedness.

b) **Applied controlling** – practices in the public sector, public finance, and other organisational environments.

[11] **VOSviewer**: a software tool for analyzing and visualizing bibliometric data, enabling the creation and mapping of networks (e.g., publications, researchers, or journals) based on citation, co-authorship, or co-citation relationships. Available at: https://www.vosviewer.com

[12] **Data visualization**: an essential part of the data analysis process, requiring visualization after data collection, processing, and modeling in order to draw conclusions.

c) **Supporting controlling** – methodological and technological tools that facilitate the operation of controlling.

Within the examined period, theoretical publications accounted for 18%, applied studies for 39%, and supporting articles for 43%. This indicates a shift of research focus toward supporting tools, while theoretical foundations and practical applications remain integral components.The author collaboration network was analysed using VOSviewer. As shown ineredmények *Figure 4*, several closely cooperating research groups have emerged. Within these networks, key nodes are authors with multiple publications or those bridging clusters. The visualisation revealed that controlling appears in the publication space as a complex, interdisciplinary field rather than an isolated topic. The citation network was also examined (*Table 7*). Findings indicate that a few seminal works and influential authors hold significant citation weight in both Hungarian and international research, providing a framework for further studies. At the same time, newer research directions have also emerged, shaping the discourse in recent years. Overall, the statistical and network analysis results suggest that controlling is a dynamically evolving research area. Both the temporal and thematic analyses highlight the increasing prominence of public sector controlling issues, particularly in the context of global challenges.

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2.2.1 Theoretical Controlling Group

Publications in this category (*Table 2*) focus on the conceptual frameworks, historical development, and theoretical linkages of controlling (e.g., performance management, resilience, digitalisation theory), or provide systematic literature reviews (e.g., digital transformation, data-driven controlling).

- Bagdács [2] presents the development of controlling from the 20th century to the present, emphasizing the impacts of digitalisation and globalisation.
- Zéman [52], [53] provides a comprehensive analysis of controlling's historical trajectory and future research directions.
- Blumné Bán and Zéman [9], along with Thalmeiner et al. [47], systematise historical and theoretical controlling perspectives.
- Szukits et al. [45] conduct a systematic review on the digital transformation of the controller profession.

- Bajnai [4], Bajnai–Fenyves [5], and Zéman–Vajda–Thalmeiner [55][56] discuss theoretical impacts of digitalisation and data-driven controlling.

Key finding: Controlling functions as a complex performance management tool integrating planning, monitoring, and information provision. In the public sector, this approach is complemented by specific objectives such as public interest and accountability [9], [53]. The theory of controlling continues to evolve: from classical cost accounting and planning frameworks todata-driven, digitalised decision support. Hungarian authors (e.g., Zéman, Bajnai) highlight local specificities and promote the integration of research and education in controlling.

Ref.	Author(s) & Title of Publication	Methodology	Key Findings	Classification
[2]	P. Bagdács – A kontrolling fejlődése a 20. századtól napjainkig [in Hungarian]	Literature review	Historical trajectory, conceptual evolution and periodization of controlling	Theoretical controlling
[4]	P. Bajnai – A vállalati controlling funkció digitális átalakulásának sajátosságai a hazai szolgáltató szektorban [in Hungarian]	Theoretical review/analysis	Digital transformation of controlling functions, role changes	Theoretical controlling
[5]	P. Bajnai, V. Fenyves – A controlling szerepének és eszköztárának átalakulása a digitalizáció hatására [in Hungarian]	Theoretical review/analysis	Impact of digital trends on controlling functions and tools	Theoretical controlling
[9]	E. Blumné Bán, Z. Zéman – Controlling a vezetés szolgálatában. történeti fejlődés, perspektívák [in Hungarian]	Theoretical review/analysis	Historical perspective of management and controlling	Theoretical controlling
[45]	Á. Szukits, L. Sztrida, I. A. Szabó – Információs folyamatok digitalizációjának hatása a kontrolleri szakmára – Szisztematikus irodalomáttekintés [in Hungarian]	Literature review	Effect of digitalization on the controller profession	Theoretical controlling
[47]	G. Thalmeiner, Á. Suhajda, M. Tóth – Teoretikus kontrolling szemléletek [in Hungarian]	Theoretical review/analysis	Controlling schools and theoretical approaches	Theoretical controlling
[52]	Z. Zéman – A kontrolling fejlődéstörténetének főbb irányzatai [in Hungarian]	Theoretical review/analysis	Historical development and directions	Theoretical controlling
[53]	Z. Zéman – Controlling kutatás jelene és jövője [in Hungarian]	Theoretical review/analysis	Future research directions	Theoretical controlling

[55]	Z. Zéman, G. Vajda, G. Thalmeiner – A controlling fejlődés új iránya, az adatvezérelt controlling [in Hungarian]	Theoretical review/analysis	Data-driven controlling, conceptual renewal	Theoretical controlling
[56]	Z. Zéman, G. Vajda, G. Thalmeiner, S. Gáspár – A controlling fejlődés új iránya, az adatvezérelt controlling [in Hungarian]	Theoretical review/analysis	Data-driven controlling, conceptual renewal	Theoretical controlling

Table 2: Publications assigned to the theoretical controlling group (prepared by the authors)

2.2.2 Supporting Controlling Group

This category (*Table 3*) covers literature on supporting activities that make theory and practice operational through methodological/technological solutions and organisational infrastructure (HR, competencies, culture, education, research).

- Fabricius-Ferke [15][16][17] analyzes megatrends and IT support.
- Becsky-Nagy–Droppa [7], Koppány–Kresalek [31][32], and Koppány [29][30] describe methodological development and controlling toolkits.
- Gábor–Barna [23], Kaposi-Szász [27] emphasize HR-controlling.
- Czirkus–Medveczky [13], Kovács [33], Doszpoly [14] approach the topic from performance measurement and competency needs.
- Fekete [19], Kalmár [26] highlight BI and big data as supporting technologies.
- Fedchenko et al. [18] and Felício et al. [20] underline the quality-improving role of controlling systems in the public sector.

Key finding: The successful operation of controlling systems is determined by the combined effect of technological infrastructure, managerial commitment, and organisational culture [7], [29]–[31]. Digitalisation plays a prominent role, but it can only effectively support decision-making if the organisation adopts a data-driven approach [18]. Accordingly, supporting functions are increasingly linked to data-driven systems (e.g., Power BI, big data) [19], [26]. Moreover, supporting controlling also plays an essential role in HR, leadership support, and public sector quality improvement.

Ref.	Author(s) & Title of Publication	Methodology	Key Findings	Classification
[3]	P. Bajnai – A controlling eszköztárát átalakító digitális technológiák térnyerése - hazai helyzetkép egy kérdőíves kutatás alapján [in Hungarian]	Case study	Adoption of digital technologies in decision-support toolkits	Supporting controlling
[7]	P. Becsky-Nagy, D. Droppa – Cash flow-kimutatások a controlling szolgálatában [in Hungarian]	Case study	Liquidity and risk support through cash flow analysis	Supporting controlling

[10]	E. Böcskei, É. Bácsné Bába, V. Fenyves – A controlling oktatásának és kutatásának helyzete az elmúlt évtized tükrében [in Hungarian]	Case study	Education and research status, ensuring new generations	Supporting controlling
[13]	L. Czirkus, B. Medveczky – A controlling a gazdálkodó szervezetek teljesítményértékelésében [in Hungarian]	Case study	Performance measurement, feedback to management	Supporting controlling
Ref.	**Author(s) & Title of Publication**	**Methodology**	**Key Findings**	**Classification**
[14]	P. Doszpoly – Küszöbön a digitalizáció: A kontrollerekkel szemben támasztott kompetencia-elvárások változása – szakirodalmi áttekintés [in Hungarian]	Literature review	Digital trends and competency requirements	Supporting controlling
[15]	G. Fabricius-Ferke – Controlling: Management, vagy leadership? [in Hungarian]	Theoretical review/analysis	Controlling as a leadership-supporting function	Supporting controlling
[16]	G. Fabricius-Ferke – A controlling megatrendek egyes információ-technológiai vonatkozásai [II. rész] [in Hungarian]	Theoretical review/analysis	IT megatrends and digitalization background II	Supporting controlling
[17]	G. Fabricius-Ferke, Z. Céman – A controlling megatrendek egyes információ-technológiai vonatkozásai (I. rész) [in Hungarian]	Theoretical review/analysis	IT megatrends and digitalization background I	Supporting controlling
[18]	E. Fedchenko, N. Savina, T. Timkin, I. Lipatova, A. Vinogradova – Developing a controlling system as a factor in improving the quality of public administration	Case study	Improving quality of public sector through controlling system development	Supporting controlling
[19]	Z. Fekete – Hogyan hat a kontrolling szakmára a Power BI, mint új trend? [in Hungarian]	Case study	BI visualization accelerates decision-making, enhances transparency	Supporting controlling
[20]	T. Felício, A. Samagaio, R. Rodrigues – Adoption of management control systems and performance in public sector organizations	Case study	Adaptation of management control systems and performance in the public sector	Supporting controlling
[21]	V. Fenyves, K. Dajnoki – Controlling eszközök a humán erőforrás gazdálkodás területén [in Hungarian]	Case study	HR controlling applications and effectiveness	Supporting controlling
[22]	G. Ferke – Pénzügyi operatív controlling informatikai támogatása, a kintlévőségek és tartozások időstruktúrájának kezelésénél [in Hungarian]	Case study	Digitalized support for financial processes	Supporting controlling

[23]	Á. Gábor, Z. Barna – A HR funkciók szerepe a controlling fókuszú szervezetben [in Hungarian]	Case study	Integration of HR and controlling	Supporting controlling
[24]	Á. Gábor, Á. Suhajda – A szervezeti kultúra dimenziói a controlling fókuszú szervezetben [in Hungarian]	Case study	Impact of organizational culture on acceptance of controlling	Supporting controlling
Ref.	**Author(s) & Title of Publication**	**Methodology**	**Key Findings**	**Classification**
[26]	P. Kalmár – Adattudomány és 'big data' technológia a controlling szolgálatában	Case study	Big data analytics in controlling	Supporting controlling
[27]	D. Kaposi-Szász – Kontrolling jelentősége, célja, funkcionalitása, különös tekintettel a HR kontrolling vonatkozásában [in Hungarian]	Case study	Practical application of HR controlling	Supporting controlling
[29]	K. Koppány – A controlling eltéréselemzés vizualizációja excelben: A vízesés-diagram (1. rész) [in Hungarian]	Case study	Application of waterfall charts in controlling	Supporting controlling
[30]	K. Koppány – A vízesés-diagram alkalmazási lehetőségei a controlling és az üzleti elemzés területén [in Hungarian]	Case study	Operational decision-support through visualization	Supporting controlling
[31]	K. Koppány, P. Kresalek – A controlling eltéréselemzés módszerei I. [in Hungarian]	Case study	Methodology of variance analysis I	Supporting controlling
[32]	K. Koppány, P. Kresalek – A controlling eltéréselemzés módszerei II. [in Hungarian]	Case study	Methodology of variance analysis II	Supporting controlling
[33]	B. Kovács – A controlling-folyamatok hatékonyságának mérése és növelése [in Hungarian]	Case study	Efficiency measurement, controlling as a driver	Supporting controlling
[37]	I. Lábas, F. Kondorosi – Költségvetési szervek eredményesebb működését támogató controlling [in Hungarian]	Case study	Institutional embedding, budgetary processes	Supporting controlling
[54]	Z. Zéman, J. Lukács – A kontrolling információigénye [in Hungarian]	Case study	Information quality, controlling inputs	Supporting controlling

Table 3: Publications assigned to the supporting controlling group (prepared by the authors)

2.2.3 Applied Controlling Group

This group (*Table 4*) includes studies presenting concrete case studies, sectoral applications, or organisational experiences.

- Béres [8], Krenyácz [35][36], Nikliné [41], Vácity [50] analyse controlling experiences in Hungarian healthcare institutions.
- Bajor [6], J. Kárpáti [28], Lentner et al. [38], Novoszáth [42], Pavlik [44], Tóth G. [48] present controlling systems in the public sector (public administration, higher education, public finance).
- Van Helden–Reichard [51], Bracci–Tallaki [11], Paterson et al. [43], Tahar–Menacere [46], Liapis–Spanos [39] examine international public sector controlling practices.
- Nagy [40], Gáspár–Valastyán [25], Tóth–Mester–Túróczi [49], Kozma–Gyenge–Tóth [34] present examples of lean- and supply-chain-based controlling.

Key finding: In practice, controlling has become indispensable in healthcare, education, and specific areas of public administration. Case studies show that controlling contributes to improved performance, transparency, and more efficient resource use [36], [39]. In the central budget, the system needs to ensure both fiscal discipline and accountability toward citizens [41]. Budgetary control creates a balance between financial stability and social value creation.

Ref.	Author(s) & Title of Publication	Methodology	Key Findings	Classification
[1]	M. A. Abd Aziz, H. Ab Rahman, M. M. Alam, J. Said – Enhancement of the accountability of public sectors through integrity system, internal control system and leadership practices: A review study	Case study	Impact of integrity, internal control, and leadership practices on public sector accountability	Applied controlling
[6]	T. Bajor – Kontrolling a közigazgatásban [in Hungarian]	Case study	Public administration controlling processes and specificities	Applied controlling
[8]	M. Béres – Kontrolling tapasztalatok egy szakkórház szemével [in Hungarian]	Case study	Healthcare institutional controlling experiences	Applied controlling
[11]	E. Bracci, M. Tallaki – Resilience capacities and management control systems in public sector organisations	Case study	Link between resilience and management control systems in the public sector	Applied controlling
[12]	M. Chląd, J. Jaroszyński – Controlling logistics in the supply chain	Case study	Supply chain controlling experiences	Applied controlling

[25]	S. Gáspár, G. Valastyán – Lean eszközök és módszerek megjelenése és vizsgálata a controlling rendszerekben [in Hungarian]	Case study	Lean integration in controlling systems	Applied controlling
[28]	J. Kárpáti – Vállalati kontrolling módszerek alkalmazási modellje az állam működésének értékelésében [in Hungarian]	Case study	Adaptation of corporate methods in state evaluation	Applied controlling
Ref.	**Author(s) & Title of Publication**	**Methodology**	**Key Findings**	**Classification**
[34]	T. Kozma, B. Gyenge, R. Tóth – Ellátási lánc controlling [in Hungarian]	Case study	Supply chain performance and coordination	Applied controlling
[35]	É. Krenyácz – A hazai egészségügyi intézmények kontrolling-rendszere [in Hungarian]	Case study	Healthcare institutional controlling experiences	Applied controlling
[36]	É. Krenyácz – Controlling in Hungarian hospitals: History and key issues	Case study	Public finance reforms and accrual accounting	Applied controlling
[38]	C. Lentner, P. Molnár, V. Nagy – Accrual accounting and public finance reforms in Hungary: The study of application in the public sector	Case study	Budgeting and controlling practice in the Greek public sector	Applied controlling
[39]	K. Liapis, P. Spanos – Public accounting analysis under budgeting and controlling process: The Greek evidence	Theoretical review/analysis	Link between lean and controlling	Applied controlling
[40]	T. Nagy – A lean menedzsment és a controlling kapcsolati rendszere [in Hungarian]	Case study	Implementation of standardized methodology	Applied controlling
[41]	E. Nikliné Gáldonyi – Az egységes kontrolling módszertan és implementációjának tapasztalatai [in Hungarian]	Case study	Institutional practical overview	Applied controlling
[42]	P. Novoszáth – A kontrolling szerepe és főbb kihívásai a jelenlegi magyar köz- és nonprofit szférában [in Hungarian]	Case study	Governance, anti-corruption and management control systems	Applied controlling
[43]	A. S. Paterson, F. Changwony, P. B. Miller – Accounting control, governance and anti-corruption initiatives in public sector organisations	Case study	Higher education controlling, competition, and measurement frameworks	Applied controlling

[44]	L. Pavlik – Verseny és controlling a közszféra egy fontos szegmensében, a felsőoktatásban [in Hungarian]	Case study	Public sector controlling in developing countries	Applied controlling
[46]	A. Tahar, K. Menacere – Management accounting practices in the public sector of developing countries	Theoretical review/analysis	Indicator theory in budget sustainability	Applied controlling
Ref.	**Author(s) & Title of Publication**	**Methodology**	**Key Findings**	**Classification**
[48]	C. Tóth G. – A költségvetés fenntarthatóságát mérő mutatók előrejelző képessége [in Hungarian]	Case study	Risk and performance in supply chains	Applied controlling
[49]	R. Tóth, É. Mester, I. Túróczi – Ellátási lánc eredményessége, valamint a felmerülő kockázati tényezők a controlling rendszer tükrében [in Hungarian]	Case study	Public finance reforms and accrual accounting	Applied controlling
[50]	J. Vácity – Esetszintű kontrolling - naprakész adatokkal [in Hungarian]	Case study	Healthcare institutional controlling	Applied controlling
[51]	J. van Helden, C. Reichard – Management control and public sector performance management	Theoretical review/analysis	Integration of management control systems in the public sector	Applied controlling

Table 4: Publications assigned to the applied controlling group (prepared by the authors)

2.2.4 Public Sector – Central Budget Perspective

Publications selected here examine the role of controlling specifically through the lens of the central budget:

- Van Helden–Reichard [51]: Review of the relationship between performance management and controlling in European public sectors. The authors emphasise the institutional significance of budgetary frameworks and accountability, noting that management control tools cannot be directly transplanted from the private sector due to differences in institutional and political contexts.

- Tahar–Menacere [46]: Analysis of controlling and management accounting in developing countries' public sectors, highlighting structural and institutional deficiencies as barriers.

- Bracci–Tallaki [11]: Investigation of management control's role in resilience within the public sector, stressing the importance of budgetary control flexibility in crisis management.

- Novoszáth [42]: Examination of central budgetary institutions' controlling practices, pointing out a lack of strategic alignment and challenges in performance measurement.

Key finding: The selected public sector/budget-focused literature consistently shows that central budget controlling operates within a unique embeddedness, distinct from corporate controlling. Sector-level challenges include a lack of strategic alignment, the dominant role of the institutional environment, difficulties in performance measurement, crisis management functions, and structural constraints.

2.3 Outlook: Current and Future Challenges in Disaster Management from the Perspective of Systematic Literature Analysis

In Hungary, the mission of disaster management is unequivocal: "In the service of Hungary for safety." In pursuing this mission, the organisation's activities aim to ensure the safety of life and property for the population, while also strengthening social responsibility. This encompasses both the mitigation or elimination of the negative impacts of natural hazards and the management of emerging challenges posed by rapidly evolving trends in robotics, digitalisation, information and communication technologies, such as cybersecurity, digital assistants, and blockchain technology. **From a controlling perspective, disaster management is characterised by the need for decision support systems that simultaneously ensure rapid real-time responsiveness, measurable cost efficiency, and optimal resource allocation.** The introduction of new tools and technologies enables the identification of related theoretical and practical aspects through systematic literature analysis and opens opportunities for further targeted investigations. Without claiming completeness, the following research directions can be outlined:

- **Protection of Critical Infrastructures**[13]: Technological advancements create new opportunities for identifying vulnerabilities and strengthening protection, while simultaneously increasing the need for continuous engagement against cyber threats and natural disasters. A systematic literature review can reveal which controlling and decision-support tools facilitate rapid responses, optimal allocation of resources (e.g., human capital, organisational structures, information), and assurance of sustainability in critical infrastructure protection.

- **Drone Technology**[14]: Drones have become central for site assessment, intervention support, and monitoring of at-risk areas. A systematic literature analysis could elucidate the methodological characteristics and efficiency factors of drone applications in both international and domestic practices.

- **Artificial Intelligence (AI)**[15]: AI solutions (e.g., modelling, text and image processing) can be applied across multiple aspects of decision support, from risk assessment to logistical planning. A systematic review conducted according to the PRISMA methodology, can help identify the most relevant application areas.

[13] **Protection of Critical Infrastructures**: This encompasses all activities aimed at safeguarding essential systems, facilities, and networks (e.g., drinking water, electricity, telecommunications networks, and the internet) against physical, IT-related, natural, or human-induced hazards.
[14] **Drone Technology**: The technical and operational toolkit of drones (remotely piloted aerial vehicles), encompasses their engineering characteristics and potential applications.
[15] **Artificial Intelligence (AI)**: Computer systems and software capable of imitating tasks that require human-like intelligence, such as learning, problem-solving, reasoning, planning, and decision-making.

- **Big Data**[16] and **Data Science**[17]: The rapid and efficient processing of large volumes of data generated during disaster management provides new decision support opportunities for end-users. Systematic analyses can reveal the effectiveness and security segments of data science tools.

- **Organizational Resilience**[18] and **Human Resources (HR)**[19]: Reviewing the literature can contribute to assessing and developing the adaptive capacities of disaster management organisations (e.g., adaptability, competence development, knowledge sharing) and identifying directions for organisational improvement.

In addition to international examples, a substantial body of domestic literature can also serve as a foundation. Several studies published in **Védelem Tudomány** have addressed the intersection of technological innovations and disaster management activities, including the practical use of drones, the protection of critical infrastructure, and the role of data science in risk management. These sources, when systematically analysed, provide a scientifically grounded framework that can supports the enhancement of disaster management operations.

Representative domestic and international publications include:

[62]J. Mógor and I. Angyal. „A kritikus infrastruktúrák ellenálló képesség fejlesztését célzó szabályozás mérföldkövei 2022-2025", *Védelem Tudomány*, vol. 10, no. 2, pp. 11-21, 2025. [in Hungarian].

[63]I. Szalkai. „Veszélyes üzemek vizsgálata drón eszközzel", *Védelem Tudomány*, vol. 8, no. 1, pp. 198-211, 2023. [in Hungarian].

[64]L. Egyed. „Drónok használatának lehetőségei a katasztrófavédelemnél, különös tekintettel a tűzvédelmi prevencióra and a kárelhárításra", *Védelem Tudomány*, vol. 8, no. 1, pp. 124-143, 2023. [in Hungarian].

[65]E. Podholiczki. „Mesterséges intelligencia alkalmazási lehetőségei a katasztrófavédelemben I. rész", *Védelem Tudomány*, vol. 10, no. 1, pp. 1-30, 2025. [in Hungarian].

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[67]S. Barnabás and R. Nagy. „Katasztrófák elleni védekezés informatikai támogatásának egyes kérdései", *Védelem Tudomány*, vol. 6, no. 2, pp. 1-16, 2021. [in Hungarian].

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[69]T. Hábermayer, P. Hartner és Á. Muhoray. „A globális katasztrófa előrejelző és koordinációs, valamint a közösségi veszélyhelyzeti kommunikációs és információs rendszerek bemutatása", *Hadmérnök*, vol. 13, no. 3, pp. 203-218, szept. 2018. [in Hungarian].

[70]Hábermayer T., Hornyacsek J. és Á. Muhoray. „Katasztrófavédelmi önkéntesek motiváció kutatása a védekezések hatékonyságának növeléséhez", *Hadmérnök*, vol. 13, no. 2, pp. 159-173, 2018. [in Hungarian].

[16] **Big Data**: A complex technological environment that enables the collection, storage, processing, and analysis of extremely large and intricate datasets, whose size and complexity exceed the capacity of traditional data storage systems or conventional processing methods.

[17] **Data Science**: A scientific discipline focused on extracting information and knowledge from large datasets using scientific methods, mathematical and statistical procedures, and computational tools (e.g., machine learning).

[18] **Organizational Resilience**: The capacity of an organization to adapt, remain flexible, and sustain its operational continuity under adverse conditions.

[19] **Human Resources (HR)**: The knowledge, skills, competencies, and motivations of employees, which are leveraged by the organization to achieve its objectives.

[71]T. Hábermayer, I. Varga, A. Kricskovics és M. Vénosz. „A halálos tűzesetek számának csökkentése és a kritikus kockázati csoportok védelme egyszerűsített tűzkockázat-elemzéssel", *Scientia et Securitas*, vol. 5, no. 3, pp. 308-322, 2024. [in Hungarian].
[72]P. Trucco, E. Cagno, F. Ruggeri, and O. Grande. „Loss and damage assessment in critical infrastructures due to extreme events", *Safety Science*, vol. 148, p. 105682, 2022.
[73]M. Erdelj, M. Król, and E. Natalizio. „Wireless sensor networks and multi-UAV systems for natural disaster management", *Computer Networks*, vol. 124, pp. 72-86, Sep. 2017.
[74]M. Yu, C. Yang, Y. Li, and B. Zhou. „Big data in natural disaster management: a review", *Geosciences*, vol. 8, no. 5, p. 165, 2018
[75]S. Ghaffarian, F. R. Taghikhah, and H. R. Maier. "Explainable artificial intelligence in disaster risk management: Achievements and prospective futures," International Journal of Disaster Risk Reduction, vol. 98, Article 104123, Nov. 2023.
[76]Akhyar, A., M. A. Zulkifley, J. Lee, T. Song, J. Han, C. Cho, S. Hyun, Y. Son, and B. W. Hong. "Deep artificial intelligence applications for natural disaster management systems: A methodological review," Ecological Indicators, vol. 163, Article 112067, 2024

Key Finding: Future challenges in disaster management require a multidimensional approach, in which systematic literature analysis plays a crucial role in the scientific evaluation of emerging technologies (e.g., drones, artificial intelligence, big data, organisational solutions, protection of critical infrastructures), thereby enhancing the effectiveness of decision-support systems and promoting the sustainable functioning of the public sector.

3. SUMMARY

The research results highlight that controlling in public sector management has evolved from being a supplementary function into a **strategically significant tool** over the past decade. The systematic literature review processed 56 relevant publications from the last decade, which were categorised into three main thematic groups: theoretical control, supporting control, and applied control. Findings from the **theoretical group** indicate that the concept of control has undergone continuous development, from classical cost accounting and planning frameworks to data-driven and digitalised decision support. Hungarian researchers emphasised the specific characteristics of the domestic public sector and highlighted the importance of linking controlling education with scientific research. The **supporting group** analysis revealed that the combined influence of technological infrastructure, managerial commitment, and organisational culture fundamentally determines the effectiveness of controlling systems. Digitalisation and data science tools (e.g., big data, Power BI, artificial intelligence) open new dimensions in planning and monitoring the use of public funds. However, technological innovation alone is not sufficient: organisational readiness and adequate human resource capacity are indispensable. The **applied group** demonstrated that the use of control across various subsystems of the public sector (healthcare, education, municipal sector, and central institutions) provides significant added value. Case studies show that controlling facilitates the measurement of efficiency, effectiveness, and economy, while also supporting the development of rapid responses to crises. The temporal distribution of publications revealed a **cyclical pattern**, with the number of studies increasing significantly in odd years, mainly in response to global social and economic crises. This indicates that both the science and practice of controlling are closely connected to external environmental challenges, which generate new research directions and compel innovative solutions. **The study also addresses the potential for synthesising theoretical perspectives on current and prospective challenges in disaster management through systematic literature analysis.** Overall, controlling is increasingly appearing in central budget-related economic domains as an **integrated decision-support tool**.

4.1 PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

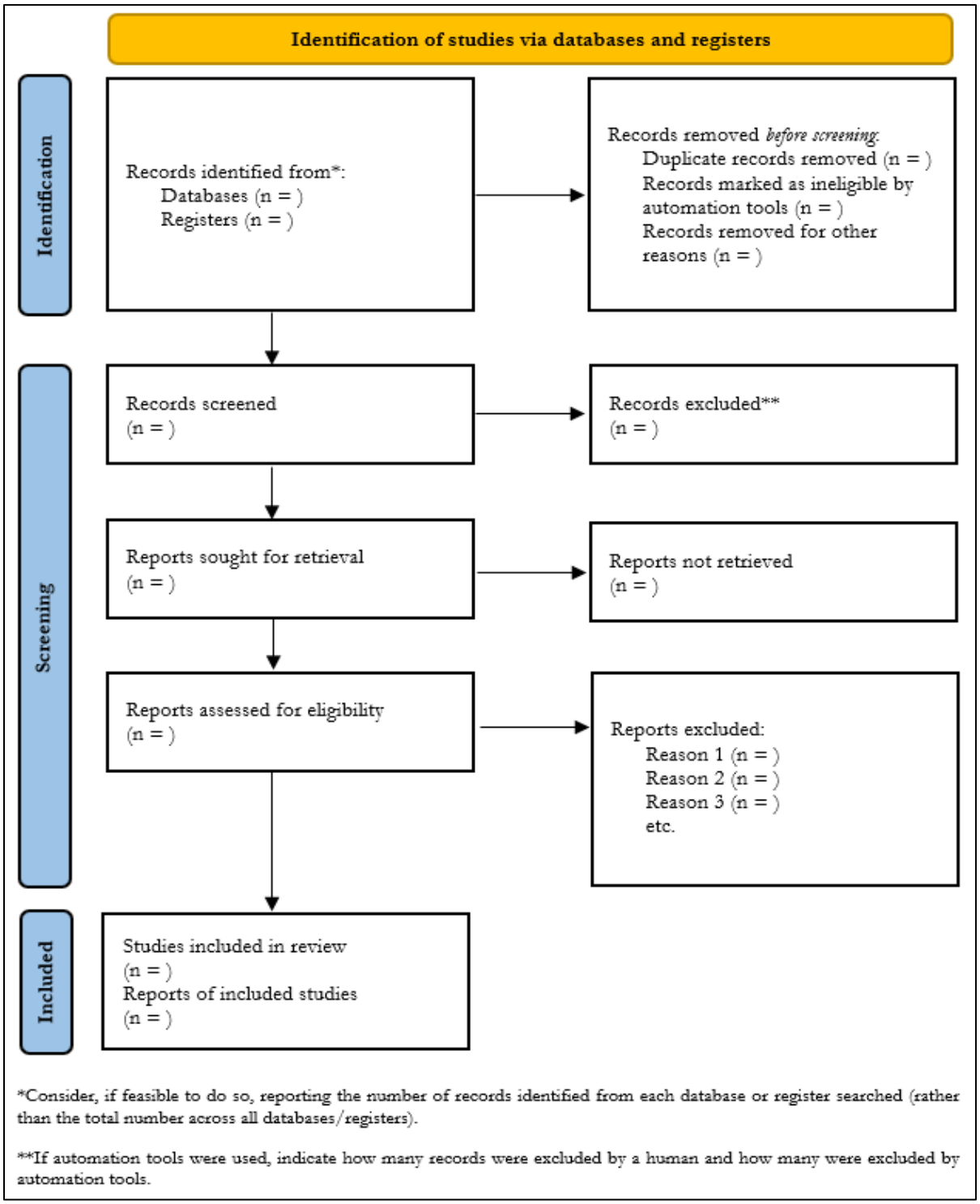

Figure 3: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only [59]

4.2 PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist (*Table 6*).	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they	

Section and Topic	Item #	Checklist item	Location where item is reported
		worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram (*Figure 3*).	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	
Results of individual	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an	

Section and Topic	Item #	Checklist item	Location where item is reported
studies		effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	
Competing interests	26	Declare any competing interests of review authors.	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

Table 5: PRISMA 2020 Checklist [59]

4.3 PRISMA 2020 for Abstracts checklist[20]

Section and Topic	Item #	Checklist item
TITLE		
Title	1	Identify the report as a systematic review.
BACKGROUND		
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.
METHODS		
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.
Synthesis of results	6	Specify the methods used to present and synthesise results.
RESULTS		
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).
DISCUSSION		
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).
Interpretation	10	Provide a general interpretation of the results and important implications.
OTHER		
Funding	11	Specify the primary source of funding for the review.
Registration	12	Provide the register name and registration number.

Table 6: PRISMA 2020 for Abstracts checklist[20] [59]

[20] This abstract checklist retains the same items as those included in the PRISMA for Abstracts statement published in 2013,54 but has been revised to make the wording consistent with the PRISMA 2020 statement and includes a new item recommending authors specify the methods used to present and synthesise results (item #6).

4.4 Observation of the authors' publication relationships

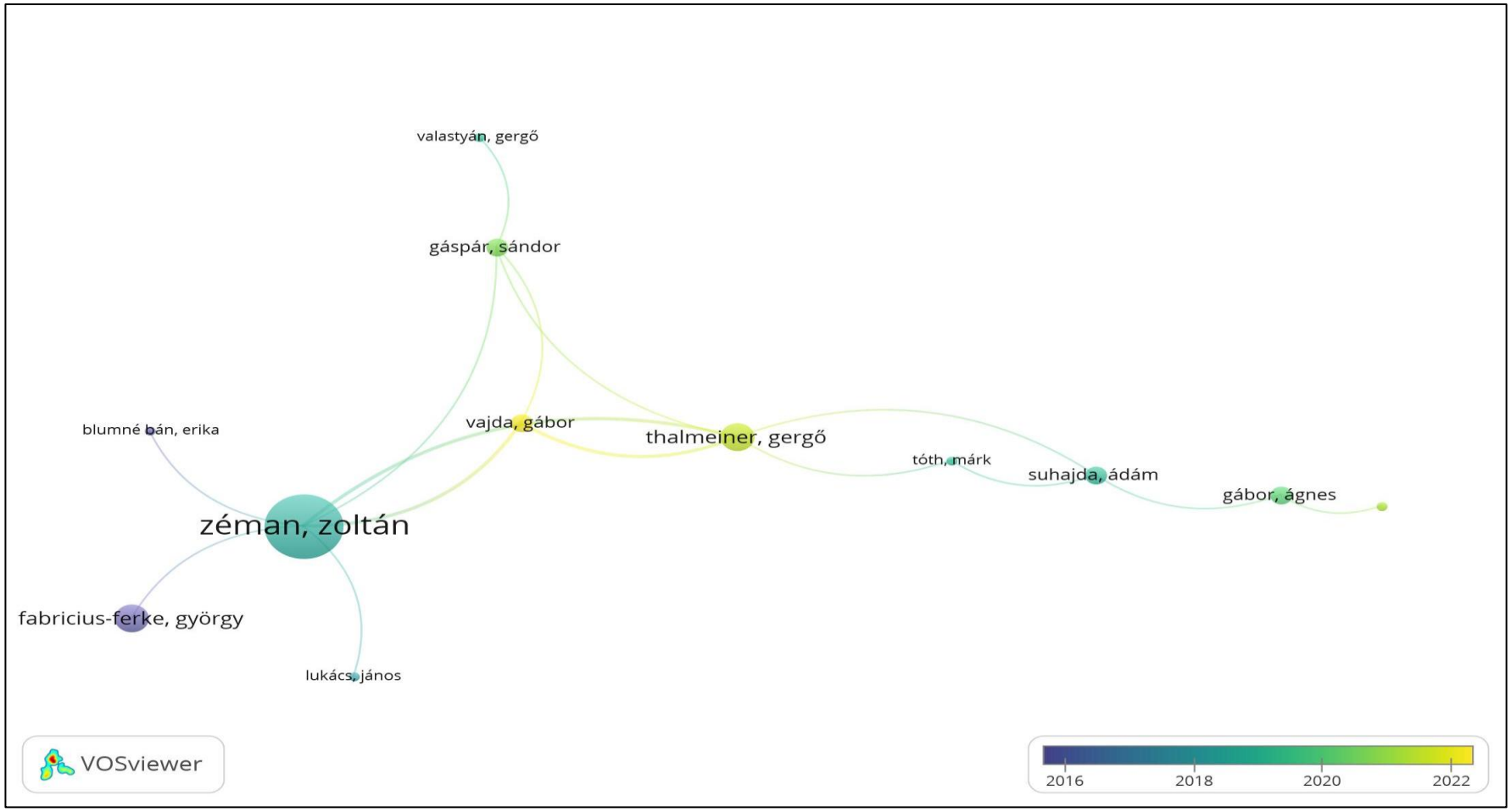

Figure 4: Observation of the authors' publication relationships (created by the authors using VOSviewer)

4.5 Clustering of authors[21]

Data: identification of the relevant cluster

Author	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Zsolt Barna	**X**			
Ágnes Gábor	**X**			
Ádám Suhajda	**X**			
Márk Tóth	**X**			
Erika Blumné Bán		**X**		
György Fabricius-Ferke		**X**		
János Lukács		**X**		
Zoltán Zéman		**X**		
Sándor Gáspár			**X**	
Gergő Valastyán			**X**	
Gergő Thalmeiner				**X**
Gábor Vajda				**X**

Table 7: Clustering of authors (created by the authors using VOSviewer)

[21] Created using the VOSviewer software.

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