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RELATIONSHIPS IN THE INNOVATION ECOSYSTEM: THE PERSPECTIVE OF VC FUNDS

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Purpose: The paper focuses on the relationships that venture capital (VC) funds develop with other actors in the innovation ecosystem. The main objective of the paper is to identify the nature of these relationships in order to support development of management process.
Design/methodology/approach: Systematic literature review was used to recognize state of the art in the field of the functioning of VC funds within the innovation ecosystem. Web of Science and Scopus were selected to the search procedure. Quantitative and qualitative analysis of the selected publications was conducted.
Findings: Most of the publications deal with the bilateral relationships between VC funds and startups. The broader background of the VC funds relationships with other actors, such as business accelerators, incubators, clusters or bridging institutions, is overlooked. No publications were found that described good practices for managing VC relationships in innovation ecosystems.
Research limitations/implications: Analysis was limited to academic publications that follow the selected search criteria and were published in English. Further studies related to publications in other languages and indexed in another database of peer-reviewed academic literature are required.
Practical implications: There is a strong focus on the VC–startup relationship, but a little attention is paid to how VC funds collaborate with other crucial players in the innovation ecosystem. The nature of VC fund relationships is sensitive and variable. The intensity of the relationship may be reflected in the evolution of investment exits.
Social implications: By strengthening the relationship between VC and innovation ecosystem, the paper supports startup growth, enhances market competition and generates positive social and environmental impacts through more sustainable and innovative products.
Originality/value: The paper contributes to existing knowledge on innovation ecosystems, shedding more light on VC funds. It systematises the existing literature, which can support in identification of cognitive gaps and provide a basis for conducting application-oriented research. The issues described can serve as an inspiration for investment managers, business developers, founders of startups and researchers.
Keywords: Venture Capital, Ecosystem, Relationship, Startup, Systematic Literature Review.
Category of the paper: Research paper.

1. Introduction

Early-stage startups seek to raise capital in order to scale up, develop a profitable business model, establish infrastructure and hire skilled employees (Panda, Dash, 2016). Venture capital (VC) investment funds support startups, as they provide financial resources, but also increase the credibility of the venture subject (Fernández-Alles et al., 2014). Looking at the relationships and synergies of such actors, VC-backed startups are a key driver of innovation, job creation and economic growth (Vedula, Fitza, 2019). Appropriate relationship management enhances the survival and success of ventures by enabling access to critical partner resources (Shafi et al., 2020).

Both startups and the VC funds that support them operate in innovation ecosystems, in which R&D and educational institutions play a key role. In addition, there are many other actors in innovation ecosystems that perform other essential roles (Mikhailov et al., 2021). The innovation ecosystem generally consists of the government, which creates rules and regulations to support entrepreneurship, business angels, the venture capital sector and the financial market, which provides the necessary capital for startups and potential capital exits, and entrepreneurs, who build teams and implement business activities (Khyareh et al., 2019). Considering the broader innovation ecosystem, network connections with business incubators, accelerators, venture capitalists (VCs), business angels, consultants, intermediaries and government administration also take place within it (Brown et al., 2019).

VC creates alternative forms of funding, a new source of capital providers that focus on partnerships, and a process of building long-term relationships based on mutual trust and respect (McCahery, Vermeulen, 2016). Research shows that startups and companies benefit significantly from the right relationships with VC funds (Ragozzino, Blevins, 2021). Occasionally, cooperation involves conflict and can be difficult for each party (Lim, Cu, 2012). On the other hand, venture capital funds must simultaneously manage a number of relationships with investors, portfolio companies, potential acquirers and co-investors who often exert disparate influences on the investment activity and the management of the entity (Sethuram et al., 2021). Publicly-backed VC funds play a more important role in mobilising the regional innovation ecosystem through collaboration (Pierrakis, Saridakis, 2019). The cooperation and strong networking of VC funds puts them in a better position to benefit from their investments (Abell, Nisar, 2007).

While innovation ecosystems have been studied in depth in the literature, a few studies seem to describe these structures through the lens of VC funds and the relationships they establish with other entities. The main aim of this article is to identify the relevance and nature of the relationships that VC funds initiate and develop with other actors in the innovation ecosystem, such as: clusters, business environment institutions, startup accelerators, technology business incubators. In order to achieve such a goal, a systematic literature review was conducted to

systematise the existing literature in this area. The paper focuses on three main research questions:

RQ1: What is the state of the art on the subject of managing relationships between VC funds and other stakeholders in the innovation ecosystem?

RQ2: What are the main topics discussed by the researchers in terms of the functioning of and collaboration with VC funds in the innovation ecosystem?

RQ3: What is the nature of VC funds relationships within the innovation ecosystem?

The paper examines a collection of past research achievements over several decades in the area of managing relationships between venture capital funds and entities that co-create the innovation ecosystem. The conclusions of the review can be the basis for indicating directions for future research in the discussed area, as well as for formulating recommendations for the business sector, including for venture capital investment fund managers.

The article consists of four sections. The first presents a description of the research procedure applied, the second presents the results of the descriptive and thematic analysis. Further parts include a discussion and conclusions with a proposal for theoretical and practical contributions in relation to defining the role of VC funds and the relationship that exists between them and other actors in the innovation ecosystem.

2. Methods

There is a wide variety of procedures for diligently conducting a systematic literature review (SLR). Numerous literature reviews in management science are based on a narrative that often does not include a structured methodology (Briner, Denyer, 2012). Traditional reviews do not explain how the research papers were selected, nor the method of analysis for the formulation of the conclusions (Cronin et al., 2008). The key elements of systematic literature reviews are the orderly conduct of the review and the high level of transparency of the research steps (Jesson et al., 2011). The SLR procedure consists of four phases divided into seven stages (Czakon, 2011): Phase I - definition of the purpose of the study, Phase II - identification of the literature, Phase III - analytical activities, Phase IV - development of the study report. Locke et al. (Locke et al., 2013) distinguished three stages, namely: the issues motivating the problem addressed, the division into sub-themes, and the design of bibliographic references for each sub-theme. Creswell's (2017) recommended way of breaking down the stages comes down to a standardisation of activities starting with the identification of keywords and databases, followed by preliminary and detailed analyses, and ending with a description of the main topics and the impact of the work for the literature. This systematic literature review adopted the procedure, which consists of three core steps (Tranfield et al., 2003). The first is planning, followed by conducting the review, and the final stage - reporting. Considering the specificity

of the study, it was decided not to impose a time limit regarding the publications reviewed, due to the fact that both earlier and later studies could have significant value to the purpose of this article.

2.1. Review planning

According to the selected procedure for conducting a systematic literature review, the first step is planning. A visualisation of the selected systematic literature review process, including the details of each filtering phase, is presented (Figure 1).

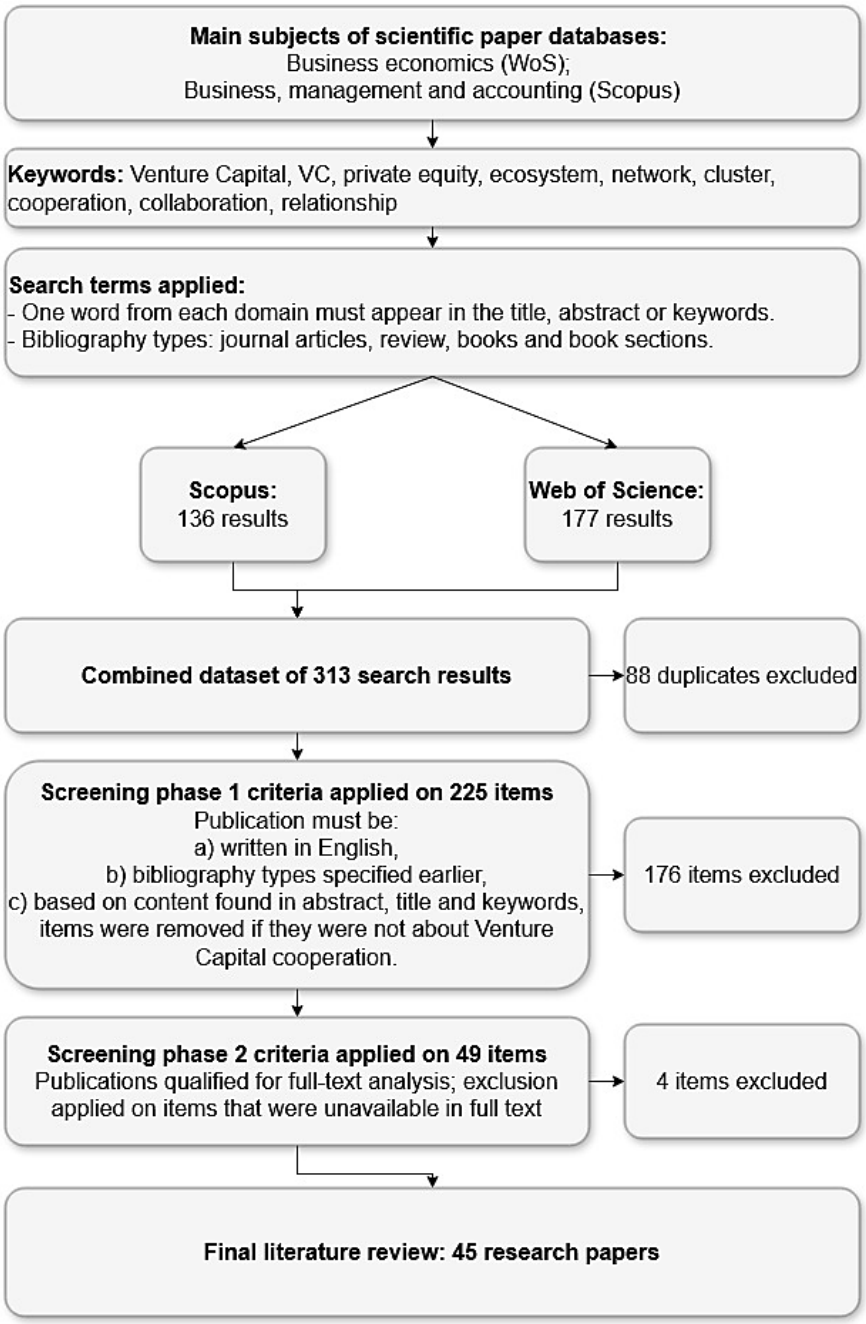

Figure 1. Flow diagram of systematic literature review process.

Source: Own elaboration.

At the beginning, a selection of the databases of research articles and an indication of the thematic areas in which filtering will take place was undertaken. This was guided by the criteria of the prestige and comprehensiveness of the databases (Guerrero-Bote, Moya-Anegón, 2012). Further conditions were applied to the selection in order to obtain the highest quality research sample. This type of action allowed a relatively large number of high-quality publications to be collected for in-depth analysis.

2.2. Conducting the review

The study used two databases of full-text scientific publications - Scopus and Web of Science (WoS). Scopus and Web of Science are widely recognized as the leading multidisciplinary citation databases for bibliometric research because they combine rigorous journal selection, high-quality metadata and reliable citation indexing. Although newer databases such as OpenAlex and Dimensions offer broader coverage, Scopus and Web of Science remain the most frequently used sources for research evaluation and systematic bibliometric analyses (Visser, Van Eck, Waltman, 2021).

It was assumed that the selected document types would be articles, review articles and book chapters, as they describe research that is up to date for the period of publication and are typically scientific. Papers from the areas of Business Economics for the WoS database and Business, Management and Accounting for the Scopus database were considered. The keywords used in the study were divided into three groups, using the logical conjunction ‘and’ between these groups:

1. “Venture Capital”, or “VC”, or “Private Equity”.
2. “Ecosystem”, or “Network”, or “Cluster”.
3. “Cooperation”, or “Collaboration”, or “Relationship”.

This was intended to be as broad as possible and to minimise the risk of publications being wrongly excluded, while keeping the theme of venture capital investment funds collaborating within the innovation ecosystem. The first group of words identified venture capital investment funds. The second group represents the cooperative aspect, i.e. the innovation ecosystem also referred to as a network and cluster for the purpose of the study. The last group of keywords is the link between the first two groups in the form of cooperation, extended to the term relationship. The application of the above filters identified 136 articles in the Scopus database and 177 articles in the WoS database (Figure 1). A total of 88 duplicate articles were identified, which helped to create a single collection of 225 documents. The mentioned results were generated as of February 11th, 2024.

Further research work was divided into two stages. Each was distinguished by criteria that resulted in the elimination of items that did not fulfil them. This was intended to generate a final article collection.

The first stage was based on the fact that the publication had to be in English and comply with the bibliography types specified earlier. The literature review was limited to English-language publications because the authors sought to review studies in their original language, thereby minimizing the risk of interpretation bias. Polish-language or other national-languages publications generally constitute a few of the records available in the databases included in the search. In addition, the content in the abstract, title and keywords had to match the concept of venture capital investment funds collaborating across the innovation ecosystem. This stage resulted in the exclusion of 176 papers, so 49 papers qualified for stage two. Narrowing the search to English emphasises the commonness of the materials and their general accessibility. The compliance with bibliography types specified earlier and the analysis of abstracts allows for the focus to be kept on the management of the relationships of venture capital (VC) investment funds with entities co-creating the innovation ecosystem (e.g.: clusters, business environment institutions, startup accelerators, technology business incubators). The analysis was driven by the fulfilment of criteria, such as: the need to address the topic of relationships and collaboration; alignment with the objectives of the article; and focus on the relationship between VC funds and innovation ecosystem actors.

In the second screening stage, 45 publications were selected for full analysis (4 articles were not fully accessed and were excluded).

2.3. Reporting

By carrying out a two-stage procedure to select the final 45 articles, a detailed descriptive and thematic analysis was initiated. The findings were mainly presented in the form of tables, supplemented by graphs. Tables 1 and 2 contain basic information about each identified article and a summary of the journals in which the papers were published. Moreover, Tables 3 and 4 provide details of the papers, referring to industry context and geographical distribution, as well as the methodology. Table 5 shows a grouping of keywords appearing in the review bibliography. The work carried out was the foundation for creating conclusions and directions for further research.

3. Results

3.1. Descriptive analysis

By analysing the increase in the number of articles on a particular topic, it is possible to understand the dynamics of the development of this area and also identify key trends and research directions. The conducted review revealed that the subject is not often addressed in the literature (Figure 2). Although the trend is increasing, the differences in the number of

publications between years are relatively small, which, combined with the intensive development of VC, indicates the existence of a considerable cognitive gap, and therefore an underestimation of the important role of the VC fund perspective in relationship management, and the need for a synthetic set of guidelines and recommendations for VC managers on the grounds of relationship management.

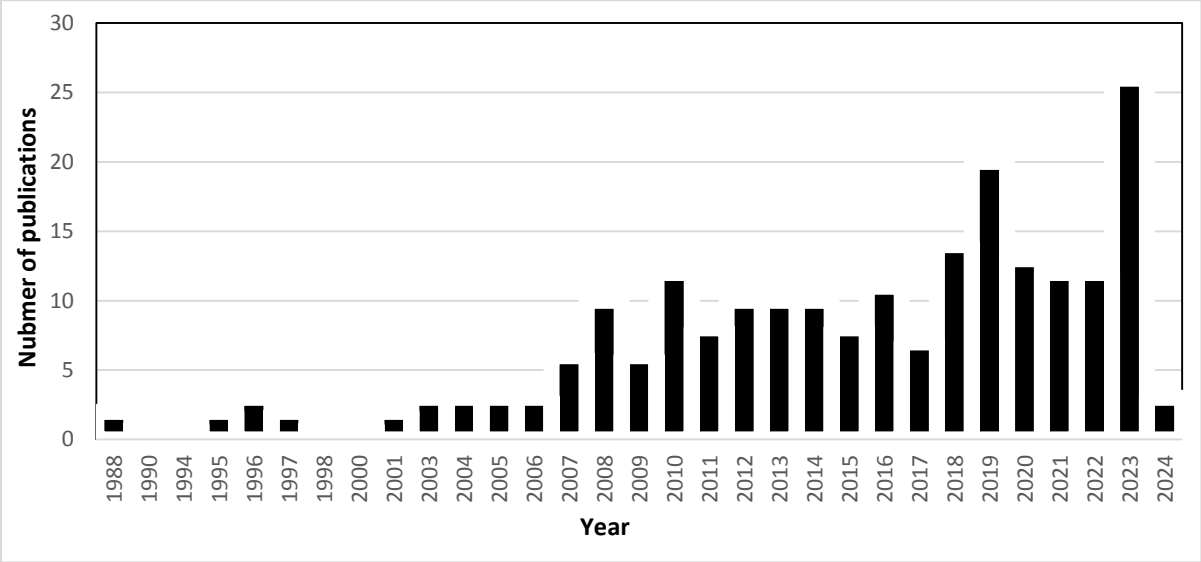

Figure 2. Yearly number of publications.

Source: Own elaboration.

The years with the highest number of publications related to the study topics (6, 8 and 6 articles, respectively) were 2019, 2020 and 2023. Only 4 articles were published in 2022 and just 1 in 2021. The lower research interest may have been due to the Covid-19 pandemic and the associated lower entrepreneurial and economic activity. The 6 papers from 2023 show that, despite the numbers from 2021 and 2022, venture capital investment fund cooperation is still of interest to researchers. It can be assessed that since 2019, research on VC fund collaboration within the innovation ecosystem has become more popular. In the other years, the number of publications did not exceed four per year. The low citation rate of the identified publications is also indicative of the low popularity of the subject (Table 1).

Table 1.
Measurements of publication citations.

	Author	Source of publication	Number of citations as of 11.02.2024
[1]	(Moazzez et al., 2020)	Journal of Science and Technology Policy Management	3
[2]	(Baaziz, 2019)	International Journal of Innovation	5
[3]	(Pierrakis, Saridakis, 2019)	Journal of Technology Transfer	27
[4]	(Wang et al., 2022)	Academy of Management Journal	17
[5]	(Goumagias, 2020)	NA (book chapter)	0
[6]	(Boutillier, 2020)	European Journal of Innovation Management	9
[7]	(Meng et al., 2023)	Journal of Innovation & Knowledge	1

[8]	(Brown et al., 2019)	Industrial Marketing Management	55
[9]	(Vedula, Fitza, 2019)	Strategy Science	34
[10]	(Trunina et al., 2020)	Chinese Management Studies	2
[11]	(Panda et al., 2020)	Industrial Marketing Management	12
[12]	(Müller, Wöhler, 2023)	Venture Capital	1
[13]	(Khyareh et al., 2019)	International Journal of Entrepreneurship	13
[14]	(Padilla-Meléndez et al., 2021)	Knowledge Management Research and Practice	9
[15]	(Shafi et al., 2020)	Academy of Management Journal	21
[16]	(Haider Alvi, Ulrich, 2023)	Journal of Business Research	2
[17]	(Zhang, Guler, 2020)	Administrative Science Quarterly	35
[18]	(Chen et al., 2024)	Technology Analysis and Strategic Management	0
[19]	(Hallen et al., 2020)	Academy of Management Annals	26
[20]	(Banal-Estañol et al., 2023)	Journal of Corporate Finance	0
[21]	(Mikhailov et al., 2021)	Innovation and Management Review	8
[22]	(Rydehell et al., 2019)	Journal of Technology Transfer	21
[23]	(Ragozzino, Blevins, 2021)	Long Range Planning	6
[24]	(Sethuram et al., 2021)	Global Strategy Journal	12
[25]	(Dushnitsky, Lavie, 2010)	Strategic Entrepreneurship Journal	85
[26]	(Tatum, 2007)	Research Technology Management	3
[27]	(Scheela, 2016)	Advances in International Management	3
[28]	(Maula et al., 2009)	Journal of Business Venturing	55
[29]	(Weber, Weber, 2007)	Journal of Engineering and Technology Management	93
[30]	(Weber, Weber, 2011)	Journal of Business Venturing	32
[31]	(Panda, Dash, 2016)	Journal of Small Business and Enterprise Development	30
[32]	(Pahnke et al., 2015)	Academy of Management Journal	131
[33]	(Strömsten, Waluszewski, 2012)	Journal of Business Research	52
[34]	(Lee et al., 2015)	Management Decision	15
[35]	(De Clercq, Dimov, 2008)	Journal of Management Studies	168
[36]	(Khanin et al., 2012)	Journal of International Entrepreneurship	5
[37]	(Fernández-Alles et al., 2014)	Journal of Technology Transfer	49
[38]	(Abell, Nisar, 2007)	Management Decision	32
[39]	(Markman et al., 2008)	Journal of Management Studies	253
[40]	(Lim, Cu, 2012)	Asia Pacific Journal of Management	13
[41]	(Leece et al., 2012)	International Journal of Entrepreneurial Behaviour and Research	9
[42]	(Høvig et al., 2012)	Southern African Journal of Entrepreneurship and Small Business Management	0
[43]	(Basole, Patel, 2018)	Service Science	32
[44]	(McCahery, Vermeulen, 2016)	Annals of Corporate Governance	11
[45]	(Yitshaki, 2008)	International Journal of Conflict Management	31

Source: Own elaboration.

The most cited article among the 45 selected was: “Research and technology commercialization” (Markman et al., 2008), published in 2008, which claims 253 citations (as of 11.02.2024) and 348 citations (as of 16.07.2026). The aforementioned paper focuses on organisational interactions involving universities and companies that result in the commercialisation of research and technology. The second highest citation score belongs to: “Internal Knowledge Development and External Knowledge Access in Venture Capital Investment Performance” (De Clercq, Dimov, 2008) with 168 (as of 11.02.2024) and 192 (as of 16.07.2026). In their article, De Clercq and Dimov examine the performance effects of two knowledge-driven strategies – internal knowledge development and external knowledge

access through inter-firm relationships – in the context of venture capital investing. When looking at Table 1, it can be assessed that older articles generate a higher number of citations. These are mainly those published between 2007 and 2010, 4 of the 5 most cited articles with more than 80 citations come from that period. From the point of view of the current state of knowledge, the issue of venture capital investment fund cooperation within the innovation ecosystem is not popular. Issues regarding the financial and economic domain of venture capital investment funds are much more widespread. In the context of business practice, the VC investment fund industry is in a dynamic phase of development, hence there is potential for managing this type of cooperation. An argument in favour of this state of affairs is the increased research interest in the subject area of venture capital funds.

Another concern of the descriptive analysis was to identify the journals in which the selected papers were published in the systematic literature review. The collection of these journals is highly diverse, and it is difficult to indicate a dominant journal (Table 2). The common denominator is the Business, Management and Accounting category (this was one of the selection criteria in the analysis): 44 of the 45 articles were published in a variety of management and business journals, with the exception of one that is focused on Arts and Humanities. Nevertheless, the mentioned paper focus on how group dynamics influence the growth of inter- organizational collaborations through the addition of new members, that is interesting form the point of understanding the described relationships. The highlighted case indicates that significant research findings are published not only in journals dedicated to business and management.

Table 2.
Citations index of journals

Journal name	No of articles	Journal subject area	H-index in SJR
Academy of Management Annals	1	Business, Management and Accounting	95
Academy of Management Journal	3	Business, Management and Accounting	358
Administrative Science Quarterly	1	Arts and Humanities; Social Sciences	201
Chinese Management Studies	1	Business, Management and Accounting	31
European Journal of Innovation Management	1	Business, Management and Accounting	74
Global Strategy Journal	1	Business, Management and Accounting	40
Industrial Marketing Management	2	Business, Management and Accounting	161
Innovation and Management Review	1	Business, Management and Accounting	11
International Journal of Entrepreneurship	1	Business, Management and Accounting; Economics, Econometrics and Finance	18
International Journal of Innovation	1	Business, Management and Accounting	no data available
Journal of Business Research	2	Business, Management and Accounting	236
Journal of Corporate Finance	1	Business, Management and Accounting; Economics, Econometrics and Finance	120
Journal of Innovation & Knowledge	1	Business, Management and Accounting; Economics, Econometrics and Finance	39
Journal of Science and Technology Policy Management	1	Business, Management and Accounting; Decision Sciences	24

Cont. table 2.

Journal of Technology Transfer	3	Business, Management and Accounting; Engineering	95
Knowledge Management Research and Practice	1	Business, Management and Accounting; Decision Sciences; Social Sciences	45
Long Range Planning	1	Business, Management and Accounting; Economics, Econometrics and Finance; Social Sciences	118
Strategy Science	1	Business, Management and Accounting; Decision Sciences	21
Technology Analysis and Strategic Management	1	Business, Management and Accounting; Decision Sciences	78
Venture Capital	1	Business, Management and Accounting; Economics, Econometrics and Finance	59
Strategic Entrepreneurship Journal	1	Business, Management and Accounting; Economics, Econometrics and Finance	61
Research Technology Management	1	Business, Management and Accounting; Engineering	77
Advances in International Management	1	Business, Management and Accounting	24
Journal of Business Venturing	2	Business, Management and Accounting	211
Journal of Engineering and Technology Management	1	Business, Management and Accounting; Decision Sciences; Engineering	71
Journal of Small Business and Enterprise Development	1	Business, Management and Accounting	80
Management Decision	2	Business, Management and Accounting; Decision Sciences	116
Journal of Management Studies	2	Business, Management and Accounting	206
Journal of International Entrepreneurship	1	Business, Management and Accounting	53
Asia Pacific Journal of Management	1	Business, Management and Accounting; Economics, Econometrics and Finance	89
International Journal of Entrepreneurial Behaviour and Research	1	Business, Management and Accounting	83
Southern African Journal of Entrepreneurship and Small Business Management	1	Business, Management and Accounting; Economics, Econometrics and Finance; Social Sciences	4
Service Science	1	Business, Management and Accounting; Decision Sciences; Mathematics	21
Annals of Corporate Governance	1	Business, Management and Accounting; Economics, Econometrics and Finance; Social Sciences	2
International Journal of Conflict Management	1	Business, Management and Accounting; Social Sciences	61

Source: Own elaboration.

The largest number of publications were in the Academy of Management Journal and the Journal of Technology Transfer (3 publications). 2 articles each were published in: Industrial Marketing Management, the Journal of Business Research, the Journal of Business Venturing, Management Decision and the Journal of Management Studies. The Academy of Management Journal deserves special mention as it has an H-index of 358 and is the definite leader compared to the others. The topics explored in the study are not very popular; however, publications appear in prestigious journals with a large audience. It is worth mentioning journals with a high H-index value such as the previously mentioned Academy of Management Journal (358 points), the Journal of Business Research (236 points), the Journal of Business Venturing (211 points),

the Journal of Management Studies (206 points), the Administrative Science Quarterly (201 points) and Industrial Marketing Management (161 points).

What is more, the articles analysed mostly referred to more than one industry, which is most likely due to the specific nature of venture capital investment funds operating in an ecosystem with other entities, often with different characteristics (Table 3).

Table 3.
Overview of the context, and geographical distribution.

	Context		**Geographical distribution**	
	Mono-industry	**Multi-industry**	**Single-country**	**Multi-country**
[1]	+	-	+	-
[2]	-	+	+	-
[3]	-	+	+	-
[4]	-	+	+	-
[5]	-	+	-	+
[6]	-	+	Non-specified	
[7]	-	+	Non-specified	
[8]	-	+	+	-
[9]	-	+	+	-
[10]	-	+	-	+
[11]	-	+	+	-
[12]	-	+	+	-
[13]	-	+	-	+
[14]	-	+	+	-
[15]	-	+	+	-
[16]	-	+	+	-
[17]	-	+	+	-
[18]	-	+	-	+
[19]	-	+	-	+
[20]	-	+	+	-
[21]	+	-	+	-
[22]	-	+	+	-
[23]	-	+	+	-
[24]	-	+	-	+
[25]	+	-	+	-
[26]	-	+	+	-
[27]	-	+	+	-
[28]	-	+	+	-
[29]	-	+	+	-
[30]	-	+	+	-
[31]	-	+	+	-
[32]	+	-	+	-
[33]	+	-	+	-
[34]	+	-	+	-
[35]	-	+	+	-
[36]	-	+	-	+
[37]	-	+	+	-
[38]	-	+	-	+
[39]	-	+	-	+
[40]	-	+	-	+
[41]	-	+	+	-
[42]	-	+	+	-
[43]	+	-	-	+
[44]	-	+	-	+
[45]	-	+	+	-

Source: Own elaboration.

The context of the selected papers refers to venture capital investment funds, the startups they fund, and innovation ecosystems in a broad sense. Mostly, the articles did not focus on the description of specific industries, hence the content of the publication often did not provide detailed information in this regard. In terms of geographical distribution, the most frequently mentioned countries were the United States (14 times), the United Kingdom (6 times) and Germany (3 times). The other researched countries were: Israel, China, India, Sweden, Iran, South Africa, Algeria, the Philippines, Spain, Canada, Singapore. The research carried out in 9 of the articles was conducted in multiple countries at the same time, which are not specified. This may indicate that the issues studied are global and international in scale. The geographical scope of the research, covering almost all continents, indicates that the subject matter has a global dimension.

In the context of the methodology applied, the most common research design was exploratory design, which applies to more than half of the articles (24) (Table 4).

Table 4.
Overview of the research design, approaches, context, and methods

	Research design	**Research approach**	**Data source**	**Data collection method**	**Data analysis**
[1]	E	Qual.	M	Documents, case study, interviews	Content analysis
[2]	E	Qual.	S	Documents, desk research	Content analysis
[3]	E	Quan.	M	Documents, desk research, questionnaire	Content analysis, regression analysis
[4]	E	Quan.	S	Documents, desk research	Content analysis, regression model, probit model
[5]	E	Qual.	S	Documents, desk research	Content analysis
[6]	D	Qual.	S	Documents, desk research	Content analysis
[7]	E	Qual. + Quan.	S	Documents, desk research	Content analysis, bionics research method
[8]	E	Qual.	M	Documents, interviews	Gioia methodology
[9]	CO	Quan.	S	Documents	Variance decomposition
[10]	E	Quan.	P	Survey	Logistic regression model
[11]	E	Qual.	P	Interviews	Inductive approach
[12]	E	Qual.	M	Interviews, archival data	Inductive approach
[13]	CA	Quan.	S	Documents, desk research	MIMIC model
[14]	E	Qual. + Quan.	M	Documents, interviews	Content analysis
[15]	CA	Quan.	S	Documents	Treatment effect models
[16]	CO	Qual.	S	Documents	Data analysis
[17]	CO	Qual.	M	Documents, interviews	Conditional logit regression
[18]	E	Qual.	M	Interviews, archival data, case study	Data analysis, case study
[19]	D	Qual.	S	Documents, desk research	Literature review
[20]	E	Quan.	S	Documents, desk research	Content analysis
[21]	E and D	Qual.	M	Documents, desk research, interviews	Content analysis
[22]	E	Quan.	P	Documents, questionnaire	Component, correlation and regression analysis
[23]	CA	Quan.	S	Documents, desk research	Statistical analysis
[24]	CA	Quan.	S	Documents, desk research	Negative binomial regressions

[25]	CA	Quan.	S	Documents, desk research	Negative binomial regressions
[26]	D	Qual.	S	Documents, desk research	Content analysis
[27]	E	Qual.	M	Case study	Content analysis
[28]	CA	Quan.	P	Survey	Regression analysis
[29]	CO	Qual. + Quan.	P	Interviews	Content analysis
[30]	E	Qual.	M	Case study	Content analysis
[31]	E	Qual.	M	Case study	Content analysis
[32]	CA	Quan.	M	Interviews	ZIP Poisson regression
[33]	E	Qual.	M	Case study, interviews	Content analysis
[34]	CA	Quan.	S	Documents, desk research	Negative binomial regressions
[35]	CA	Quan.	S	Documents, desk research	Ordered logit model
[36]	CA	Quan.	S	Documents, desk research	Ordinary least squares regression
[37]	CA	Quan.	M	Questionnaires	Binary logistic regression
[38]	E	Quan.	S	Documents, desk research	Content analysis
[39]	D	Qual.	S	Documents, desk research	Review
[40]	CA	Quan.	P	Questionnaires	Ordered logistic regression
[41]	E	Qual.	M	Case study, interviews	Content analysis
[42]	E	Qual.	P	Interviews, case study	Content analysis
[43]	E	Qual.	S	Documents, desk research	Content analysis
[44]	D	Qual.	S	Documents, desk research	Content analysis
[45]	E	Qual. + Quan.	P	Interviews, questionnaire	Content analysis

Note. Author's choice: CA – causal, CO – conceptual, D – descriptive, E – exploratory, N – narrative, Qualitative – Qual., Quantitative – Quan., Primary – P, Secondary – S, Mix – M.

Source: Own elaboration.

In 12 cases, the authors decided on a causal research design due to the verification of the hypotheses and the quantitative approach. Studies designed in a descriptive and conceptual way were less popular. Noting the research approach, the articles were diverse. 22 of them followed the qualitative approach, with 19 focusing on the quantitative approach. 4 studies were carried out using both approaches mentioned. The authors were most willing to use secondary data, which occurred in 22 cases. A mixed form combining primary and secondary data occurred in 15 publications. 8 articles were developed using primary data. Data collection methods also varied. Questionnaires were used to obtain primary data. Occasionally, authors chose to implement the case study method, which is extremely useful in qualitative research. The vast majority of articles were based on secondary data in the form of documents and archival data obtained through desk research. The most prominent method of data analysis was content analysis. Various statistical methods of data analysis were used for quantitative research, including negative binomial regressions, the inductive approach or logistic regression, among others.

3.2. Thematic analysis

This article proposes a thematic analysis focused around areas identified by keywords. The total number of keywords collected from all the selected articles was 211. They were systematised by means of the 4 main key categories and 1 additional (Table 5):

1. Management - the governance necessary for effective collaboration, development and investment delivery.
2. Ecosystem/Network - a set of key actors including VC funds, where collaboration between them takes place and specific relationships are established.

Table 5.
Grouping of keywords appearing in the review bibliography

Keyword groups	Occurrence	Keywords appearing in the review publications
Management	63	Case study, Collaboration challenges, Technological collaboration, Competitiveness, Coopetition, Quintuple Helix, Ambidextrous capabilities, Public policy, Regional development, Policy, Risk, Entrepreneur (2), Knowledge acquisition, Niche evolution, Entrepreneurship (8), Qualitative comparative analysis, Variance decomposition analysis, SME, Logistic model, B2B relationships, Decision making, Economic framework conditions, Entrepreneurial behaviour, Macroeconomic effects of entrepreneurship, Gem model, Knowledge spillover, Surrogate entrepreneurs, Tie discontinuation, Social capital (3), Longitudinal case study, Trends, Information economics, Multiple agency theory, Resource (3), Knowledge, Performance, Social liability, Knowledge transfer (2), Agency theory, Corporate governance, Organizational knowledge transfer, Knowledge diversity, Necessity entrepreneurship, Opportunity entrepreneurship, Value added, Small firm/new venture strategy, Entrepreneurialism, Transformation, Conflict resolution, Conflict.
Ecosystem/ Network	57	Network forming, Engineered collaboration network, Urbanized ecosystem, Entrepreneurial ecosystem (2), Algerian entrepreneurial ecosystem, Ecosystem's Value Chain, Networks (3), Strong and weak ties, Value symbiosis, Innovation ecosystem (2), Social networks (3), Business networks (2), Entrepreneurial networks, Regional entrepreneurial ecosystem, Network ties, Trust (2), Trust formation, Confidence, Entrepreneurial university ecosystems, Inter-organizational relationships, Reputation (2), Signaling theory, Entrepreneurial ecosystems, Incubators, Accelerators, Interorganizational relations, Syndicates, Network faultlines, Intermediaries, International innovation ecosystem, Institutions, Alliance, Network, Collaboration, Complementarities, Relationship risks, Relationship learning benefits, Relational fit, Social network dynamics, Confidence in partner cooperation, Social relations, Knowledge networks, Network density, Actors, Networking, Service ecosystem, Network analysis, Channel relationships.
Venture Capital	45	Venture capital (16), Unicorns, Financing, Banker, Corporate venture capital (5), Equity crowdfunding, VC-backed startup performance, University-focused venture capital firms, Entrepreneurial finance, Innovation finance, Venture capital firms, Founders, Individual investors, External financing, VC, IPO, Investment duration, Patient capital, Gazelles, Private equity, Corporate venture capital triad, Exit strategy, Post investment relationship, Investments, Investors, University funds.
Innovation	23	Intelligent specialization, Mutualized R&D, Innovation (3), Start-ups (3), Silicon Valley, Emerging markets (2), Innovation performance, New technology-based firms, Emerging economies, Commercialization of innovation, Technology-based new firms, Radical innovation, Developing countries, Academic spin-off (2), Spin-off development, Technology transfer, Commercialisation of research.
Other	23	Medical equipment, Useful blocks, Specialized blocks, Europe, Crisis, Agriculture, ICT, Agtech, Localization, Google, Search, Signaling, Foreignness, Institutional distance, Software, Speed, Disagreement and advice, United Kingdom, Biotech, South Africa, FinTech, Visualization, Israel.

Source: Own elaboration.

3. Venture Capital - the main focus of this literature review and the type of capital support offered by funds to startups.
4. Innovation - VC funds invest in and stimulate innovation, research and development.
5. Other - other keywords that could not be assigned to any other group.

The largest number of keywords (63) were assigned to the Management group. Articles mainly focused on entrepreneurship, economics, politics and collaborative management. Some researchers look at the importance of management in the context of startups and early entrepreneurs collaborating with VC funds (Shafi et al., 2020). This brings benefits in terms of the partner's financial resources but is fraught with risks that require efficient management. It can be found an analyse of venture capital (VC) management in innovation processes (Strömsten, Waluszewski, 2012), that shows how the management of venture capital investment funds affects startups and their innovative projects. In contrast, researchers examined the impact of knowledge management by VC funds based on two strategies - internal knowledge development and external access to knowledge through relationships between companies - in the context of venture capital investment (De Clercq, Dimov, 2008). The authors found that investing in industries where the fund has greater knowledge and networks improves investment performance. A startup that has received investment can expect more support from the fund. There is a discussion of the approach to managing cooperation in the ecosystem, which is determined by the source of capital (public or private) (Pierrakis, Saridakis, 2019). With public capital, VC funds show more experience in the way they manage cooperation. On the other hand, VC funds investing only private capital are more parsimonious in dealing with ecosystem partners. There is noted that conflict situations occur during stakeholder collaboration, hence conflict management, including conflicts of interest, is essential (Yitshaki, 2008). The main topic discussed in relation to the management, operation and cooperation of VC funds in the innovation ecosystem was their role as a funder of startups and provider of venture capital (Scheela, 2016). VC funds contribute to technology development within the innovation ecosystem and contribute to the commercialisation of research and the creation of innovations (Markman et al., 2008). The nature of VC fund relationships is sensitive and evolving as they have to pursue their investment goals and cooperate with different stakeholders (multi-stakeholder relationships) (Abell, Nisar, 2007). The intensity of the relationships may be reflected in the formation of the equity exit (Banal-Estañol et al., 2023). Venture capital funds play a key role in providing institutional and financial support to enable a startup to rapidly grow and become competitive (Scheela, 2016). Within this group, the most significant issue was reacted to the word management, which can take the form of relationship management, capital management, knowledge management; however, it all comes down to fulfilling the role of funding innovative ventures run by startups.

The Ecosystem/Network group had a lower keyword value of only 6, i.e. 57. In this group, keywords were related to various types of networks and ecosystems in the business, innovation and entrepreneurial dimension. Within this group the importance of understanding the

relationships between actors within a network or ecosystem, in particular the role of startups and venture capital funds contributing to the development of technology and entrepreneurship is highlighted (Wang et al., 2022). Researchers suggest a model for matching innovative companies with funding that is applicable to entrepreneurial ecosystems (Haider Alvi, Ulrich, 2023). They describe VC funds as a form of increasing funding opportunities for new entrepreneurs, thus stimulating projects, which helps to develop entrepreneurial ecosystems and increase their transnational significance. Researchers present the results of a study based on startups that have received crowdfunding (Brown et al., 2019). Networks and social capital play a key role in crowdfunding and VC investment. This type of funding provides startups with important relational benefits that offer "more than the funding itself". A venture capital fund is part of the innovation ecosystem and is seen as a provider of venture capital. In the ecosystem, it creates relationships with other actors through which it achieves its financial and non-financial goals, such as supporting technological development or the commercialisation of research.

The third largest group was Venture Capital (45), which was concerned with funding, investment funds, investments and capital. Using VC investments as an example, there are considered the interactions between actors in an interorganisational group, specifically focusing on relationships between VC funds (Zhang, Guler, 2020). Khanin et al. (2012) provide knowledge for venture capital funds on how to improve their performance by choosing the right strategy to enter new emerging markets. This is an opportunity for venture capital, but also a major risk due to various uncertainties, including instabilities of a regulatory nature. The following group describes the topics extracted related to relationships between VC funds, which can collaborate and make co-investments to generate more capital to support the startup.

The Innovation group differed significantly in terms of the number of keywords assigned when compared to the three previously mentioned groups. In terms of innovation, investigation of the effect of early relationships on innovation in companies from a competitive perspective is conducted (Pahnke et al., 2015). The authors concluded that indirect relationships with competitors hinder innovation, and that this effect is moderated by several factors related to insider disclosure. Other researchers describe the organisational interdependencies involving universities and companies that result in innovation and the commercialisation of research and new technologies (Markman et al., 2008). Innovation and commercialisation have their barriers at the individual, technological and organisational level, which emphasises their complexity.

The Other group contains thematic words that could not be assigned to one of the four previously identified groups - due to their nature and relevance, e.g. the location of the research or the industry to which the research related. They did not make it possible to isolate the topics discussed in relation to the functioning and cooperation of VC funds in the innovation ecosystem.

The thematic analysis using keywords indicated the importance of the ecosystem, which can provide valuable information regarding the significance and role that the ecosystem plays in the functioning of actors such as VC funds, startups, or scientific and research institutions. Of particular interest is networking, the study of connections and interactions between the different elements of the ecosystem. The creation of an ecosystem and its operation generates many challenges, which are caused by the cooperation of partners with different approaches, goals and capacities (Moazzez et al., 2020). Overcoming these barriers is possible with the trust of VC funds and startups in business organisations, clusters and science parks (the main places where innovations emerge) (Boutillier, 2020). On the other hand, the specific nature of the bond between VC and startup means that their mutual trust is limited and varies according to circumstances (startup performance, VC pressure, etc.) (Panda et al., 2020). Occasionally, this results in conflict, which is inherent in the relationship between VCs and entrepreneurs, as both parties have different concepts of the startup venture (Yitshaki, 2008). It is important to note that the relationship of VC funds within the innovation ecosystem is very sensitive, changeable and dependent on the particular situation and the other parties.

Quintuple Helix relationship-based innovation ecosystems certainly promote innovation and incorporate sustainable economic development (Baaziz, 2019). Educational and research institutions play a key role in developing new knowledge in the ecosystem. In turn, funding is important to enable startups to succeed (Mikhailov et al., 2021). Venture capital funds play a valuable role in providing the institutional and financial support that is lacking in developing economies and ecosystems to enable a startup to rapidly grow and become more competitive (Scheela, 2016). The research shows that groups of actors have their own specific tasks and objectives to fulfil within the network.

The intensity of collaboration depends on certain elements identified by the research. Publicly funded VC funds are more likely to establish relationships with other actors in the innovation ecosystem than those that do not use public funding (Pierrakis, Saridakis, 2019). Collaboration between VC funds affects the form of exit - intensive collaboration increases the chances of exit via acquisition; with less prior experience of collaboration, a funded startup is more likely to exit through an initial public offering (Wang et al., 2022). From the perspective of startups, developing relationships within the ecosystem and reputation can be essential to raising funding from a VC fund (Trunina et al., 2020). A startup with a stronger commitment to stakeholder relations may be more successful in obtaining investment from a VC fund.

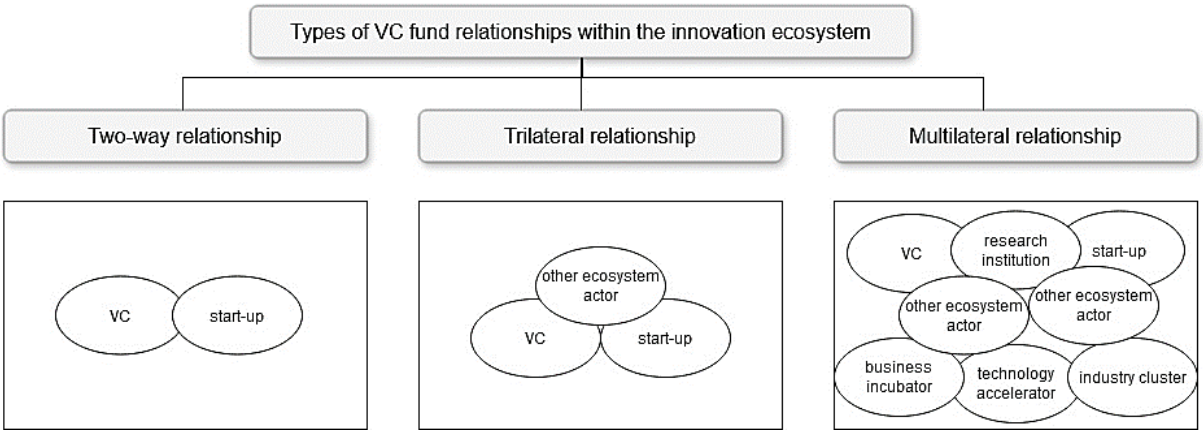

Figure 3. Types of VC fund relationships recognised in selected papers.

Source: Own elaboration.

When describing the innovation ecosystem, the following groups of relationships can be distinguished (Figure 3):

1. venture capital funds and startups (two-way relationship),
2. venture capital funds and startups and an additional actor, which can be, e.g. a university, or a large company (trilateral relationship),
3. an ecosystem in a horizontal sense (multilateral relationship).

The final category is ‘others’, which consists of aspects that could not be allocated to the four groups described above, due to their focus on a different type of cooperation. Some authors focus on corporate venture capital funds in their work (Dushnitsky, Lavie, 2010). Other researchers focus on the relationship between venture capital funds (Zhang, Guler, 2020). Both studies omit the perspective of the complex ecosystem.

The largest group by far is the two-way relationship involving venture capital funds and startups, described in 24 articles. Some authors planned to explore the inherent conflicts that exist between VC investors and startups (Shafi et al., 2020). Furthermore, some researchers propose solutions to prevent conflicts, such as the establishment of conflict management mechanisms and processes. Müller and Wöhler (2023) described the trust of VC funds in the team of originators forming a startup, which has a strong influence on investment decisions. The credibility of the originators is shaped by their working environment, reputation and the way they communicate during meetings. The perception of a person as credible creates trust and increases the willingness to make an investment.

A slightly larger scope is characterised by tripartite interaction, which can consist of a VC-startup fund relationship complemented by an actor in the form of a university (Padilla-Meléndez et al., 2021; Høvig et al., 2023). Twice as frequently (4 times), Numerous time the third party was a large company, due to the specificity of corporate venture capital funds. For instance, it is discussion about CVC's management of large enterprise investments from the startup's point of view (Maula et al., 2009).

The most capacious set is the ecosystem within which multi-stakeholder collaborations of various types take place. In 13 articles, research was conducted on ecosystems in which venture capital investment funds operate. Researchers provide the result of observing California's innovation ecosystem in the context of creating revolutionary innovations in agriculture (Mikhailov et al., 2021). There are examinations of interactions between VC investors and other actors in the innovation ecosystem, such as incubators, universities, research institutes and business support organisations (Pierrakis, Saridakis, 2019).

4. Discussion of the results

As a result of the systematic literature review, it can be concluded that the subject of managing venture capital investment fund collaboration within the innovation ecosystem has been a field of research for years; however, it has been addressed in a very limited thematic scope, mainly in the bilateral VC vs startup relationship. The continuous development of VC in ecosystems, as well as the high dynamics of changes in the relationship between VC and other ecosystem actors, requires further in-depth analysis. Although the analysed literature provides knowledge that is part of the problem of relationships in the innovation ecosystem, it does not exhaust the essence of the issue related to the creation and development of VC relationships within innovation ecosystems (Pierrakis, Saridakis, 2019). The publications analysed omit the perspective of VC funds in terms of their involvement in the innovation ecosystem and in supporting the building of a plan for the development of startups and entrepreneurs (Strömsten, Waluszewski, 2012). This is an important research gap that prevents an in-depth understanding of the issue addressed.

The conducted literature review indicates that further in-depth research is justified in the context of venture capital fund cooperation in the innovation ecosystem (Hallen et al., 2020). Areas worth exploring in the future relate in particular to taking a holistic but also detailed look at the functioning of VC funds in the innovation ecosystem, identifying and describing good practices in the management of venture capital fund relationships within ecosystems and how VCs achieve their goals.

Regarding the first proposed theme, most of the selected papers narrow their spectrum by basing their analyses and conclusions on bilateral VC fund and startup relationships. VC collaboration within the innovation ecosystem takes place in different parts of the world, so it should be deeply analysed and considered from different aspects, including geopolitical, cultural and economic. The selected papers focus on conflicts (Yitshaki, 2008), relationships (Panda et al., 2020), localization (Rydehell et al., 2019) and partnerships (Moazzez et al., 2020), as indicated in the thematic analysis. There are a few articles describing tripartite relationships (Padilla-Meléndez et al., 2021; Høvig et al., 2023) and they often marginalise the role of

VC funds. The papers examining ecosystems seem to be too general, given the collaborative management characteristics of venture capital investment funds. Entities such as business accelerators, incubators, clusters, and business environment institutions are very important from the point of view of investment activity, knowledge sharing and business development (Pierrakis, Saridakis, 2019). The findings confirmed that professionals operating within publicly-backed VC funds are more likely to interact with other players in the innovation ecosystem than professionals from VC investment funds using only private funding. Cooperation with them deserves more attention and detailed study, as they may prove to be one of the fundamental factors in the effectiveness of venture capital funds (Rydehell et al., 2019).

Concerning the second area, this article failed to identify good practices for managing VC relationships in innovation ecosystems. Neither was a synthetic set of guidelines and recommendations identified for VC investment fund managers in the field of relationship management with co-creators of the innovation ecosystem. This indicates the need to develop a relationship management architecture for VC funds, which could enable their effective and efficient cooperation with, among others, clusters, business environment institutions, business accelerators, and incubators (Fernández-Alles et al., 2014). An analysis of the key determinants of effective and efficient cooperation would allow for the identification of directions for the development of new investment funds in terms of building relationships in the innovation ecosystem. It seems that this, in the long term, would result in a higher level of funding for innovation development and support for implementation-oriented research and its commercialization (Markman et al., 2008). In conclusion, VC investment funds provide an important contribution to management and cooperation within ecosystems. This contribution develops innovation, which is an indispensable feature of such ecosystems.

The study also identified a third area worth exploring in more depth, which is how VCs achieve their objectives. Venture capital investment funds collect assets from investors and invest them in the most efficient way. These are the types of entities that are specifically targeted to achieve the expected ROI (Sethuram et al., 2021). In this case, it is an investment in a startup pursuing an innovative venture that will primarily respond to a market need, grow, be scalable and have a high impact. The above factors enable the startup to grow rapidly and thus enable the activation of a business opportunity in the form of a profitable equity exit capital (Scheela, 2016). Intensive collaboration within the innovation ecosystem can become a tool to build and support the objectives (Trunina et al., 2020). Taking into consideration the opportunities, impact and prospects connected with VC funding, this is an extremely up-to-date and promising topic.

5. Conclusions

This article uses the method of a systematic literature review to organise the available scientific knowledge in the area of the functioning of venture capital investment funds within the innovation ecosystem. The study shows that the issue of venture capital investment fund cooperation within the innovation ecosystem is not particularly popular; however, it is increasingly being addressed. The scale and impact of ventures financed and supported by VC funds indicate promising prospects, hence there is potential for managing this type of cooperation and a sense of the need to gather knowledge in this area. The main topics discussed in relation to the functioning and cooperation of VC funds in the innovation ecosystem were their role as funders of startups and providers of venture capital. VC funds contribute to the development of technology within the innovation ecosystem and contribute to the commercialisation of research and the creation of innovations. In addition, the collaboration that happens between VC funds taking the form of co-investments and syndicates is explored. The nature of VC fund relationships is sensitive and variable, as they have to pursue their investment goals related to economic efficiency and cooperate with different stakeholders (multi-stakeholder relationships). The intensity of the relationship may be reflected in the evolution of investment exits. The analysis of the literature indicated that venture capital funds play a key role in providing not only financial support, but should also support partners institutionally to enable the startup to grow rapidly and become more competitive.

The article may also have significant application value. This is because the main contribution of this paper is an in-depth analysis of the available knowledge on the topic of managing venture capital fund relationships with the major actors in the innovation ecosystem. The results of the work and research have important applications for science and business. The issues described can serve as an inspiration for a large group of actors, including investment fund managers, investment managers, business developers employed in entities creating an innovation ecosystem, originators and founders of startups. This study also has some limitations in the interpretation of the results obtained. First of all, only academic publications were taken into account within the framework of the study, thus non-academic sources of information such as: reports from the VC market, documentary studies of companies, economic analyses, etc. were omitted. These types of documents may contain data and information that are relevant to the issue under study. A second key limitation is the need to adhere to the rigour of a systematic literature review, including the search criteria adopted, which may have resulted in the omission of some valuable academic content. Moreover, only English-language publications were included in the analysis.

A valuable element of the article comprises suggestions of directions for future research on developing VC relationships within innovation ecosystems. This article proposes three main areas for research and additional analysis, although they are not exhaustive of all possible issues related to the subject under consideration.

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