

Review

# Towards a Unified Virtual Business Incubator Model: A Systematic Literature Review and Bibliometric Analysis

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**Abstract:** Virtual business incubators have been highlighted for their positive impacts in fostering entrepreneurship and innovation in several business areas, contributing to sustainable economic growth and social development. However, despite their crucial roles, previous literature emphasizes that research concerning their business models has been largely ignored, and several important issues are still unaddressed. This article aims to contribute to filling this gap and advancing this field by providing the first bibliometric and systematic literature review, as far as the authors know, concerning virtual business incubator models. The main results reveal the following: that academic production is relatively new, fragmented, and develops under a diversity of research paths; the analyzed models ( $n = 12$ ) have only some dimensions in common and are proposed based on three different perspectives (business organization and management, information and communication systems, and user experience); there is not a virtual business incubator model more suitable to support digital businesses or startups creation. Based on the results, it is argued that there is a need to further develop a model towards a unified virtual business incubator by actively involving different stakeholders during its design. This research can help managers, academics, and other professionals interested in running virtual business incubator programs.

**Keywords:** entrepreneurship; virtual incubator; model; economic development; digital transformation; digital entrepreneurship; sustainable business; framework; systematic literature review; bibliometric analysis



**Citation:** Vaz, R.; de Carvalho, J.V.; Teixeira, S.F. Towards a Unified Virtual Business Incubator Model: A Systematic Literature Review and Bibliometric Analysis. *Sustainability* **2022**, *14*, 13205. <https://doi.org/10.3390/su142013205>

Academic Editors: Daniel Francois Meyer and Rui Alexandre Castanho

Received: 5 September 2022

Accepted: 13 October 2022

Published: 14 October 2022

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## 1. Introduction

Business incubators have a crucial role in fostering sustainable economic growth and social development [1,2], holding the potential for increasing entrepreneurship, technology, and innovation in several business sectors and areas, and also in generating new job opportunities and wealth creation [3–5]. They assume multiple functions and provide several support services and assistance for strengthening new startups, existing businesses, or entrepreneurial teams, and contributing to their survival and growth, even during the most vulnerable periods. Some practical examples of incubators' contributions are offering access to consultancy services, training sessions, network and venture capital [6], assistance with the development of new products and services [7], and helping entrepreneurs to enter markets and proliferate the commercialization of their products and services [8,9], among others.

In fact, business incubators have been highlighted as promoters of business success, sustainability, autonomy, and profitability, which tend to remain even after the incubation period. Indeed, “firms which have undergone incubation, have a higher chance of survival than those that did not experience it” [10] (p. 3). For these reasons, it is understandable why business incubators have been increasing and proliferating during the last decade, most of them supported by governmental policies and practices [3,9,11].

Concerning this last aspect, and since the present research is developed under a Portuguese initiative, it is mentioned that the national incubation ecosystem is relatively new when compared to countries, such as the United States of America and other European or Asian countries. Nevertheless, a recent report from the International Data Corporation [12] concluded that it is among the best in Europe, having 169 incubators active by 2020, meaning that the number of incubators has grown by about 40% since 2016. Moreover, the same study revealed that about half of the startups are virtually incubated (51%), while 49% are in a physical incubation modality.

The literature classifies business Incubators Into several typologies, and there is no consensus among the used nomenclature and definitions. For example, some authors [3] argue that there are six types, namely the business incubator, virtual incubator, networked incubator, academic incubator, student-run incubator, corporate incubator, and social incubator. On the other hand, other authors [13] propose additional classifications, including the university incubator, the independent commercial incubator, the regional incubator, the company-internal incubator, the technology business incubator, and the virtual incubator.

Despite the concept and typologies of incubators having undergone a considerable evolution over time [13,14], research on the phenomenon of business incubators and their different business models has only recently started to register some advances [13–18]. Tang, Walsh, Li and Baskaran explain that “where incubator business models are concerned the nuances of the value creation perspective are largely ignored, treated like a black box” [13] (p. 91). This notwithstanding, the importance of these business models for incubators is well recognized for helping them to pursue their missions, allowing better support to the expected growth of their tenants, and enabling the incubator to create and capture value [19,20]. Moreover, Hausberg and Korreck [14] stress the lack of bibliometric and literature review studies regarding the field of business incubation in general, aggravated by the fragmentation of the scarce existing knowledge, which results in several important questions being left unaddressed.

Regarding the particular subject of virtual business incubator models, the present article is the first to conduct a bibliometric and systematic literature review, as far as the authors are aware, addressing a broader understanding of the evolution and development state of this field. It aims to extend previous research in several ways by contributing the following: (i) adding new information and presenting a comprehensive review of the evolution of this academic research field; (ii) systematically organizing the existing virtual incubator business models and providing further details about the operationalization of each one to support their tenants better; (iii) drawing conclusions about a model that is more suitable to virtual business incubators for supporting the process of digital business or startup creation. Three research questions guide the present research to accomplish this goal, as follows:

1. How has academic research concerning virtual business incubators’ development evolved?
2. Which virtual business incubator models exist, and how do they organize to support their tenants with business creation and development?
3. Which virtual business incubator model is more suitable to support the process of digital businesses or startup creation?

The forthcoming section details the materials and methods followed in conducting the research, after which the results from the bibliometric analysis and the systematic literature review are presented. The article proceeds with a discussion of the main findings and their implications. It finishes with the conclusions, highlighting the study’s limitations and future research directions.

## 2. Materials and Methods

A hybrid methodology combining a systematic literature review with a bibliometric analysis [21] was followed to accomplish the present study’s objective and answer the

research questions that guided it, while providing an unbiased overview of the knowledge related to the field of digital business incubators models.

Concerning the bibliometric method, it was performed mainly using the Bibliometrix R-tool [22] to analyze the bibliographic data related to the theme under study. In addition, the VOSviewer tool was also used during the report screening stage of the research to construct and visualize the bibliometric networks [23] of the screened records, as will be explained.

The systematic literature review was carried out in four main stages—planning the review, conducting the review, analyzing and synthesizing the retrieved data, and reporting the results—as recommended by [21,24], and followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines [25]. After conducting an initial exploratory search of the literature, it was possible to gain an overview of the most common terminology related to the topic under analysis, and the filtering criteria to use to sample the records was defined.

The identification of the records took place on the 1 August 2022, by querying the Web of Science database (chosen for its recognized comprehensiveness of the literature in management science-related topics [7,14,26]), using the following search string: `business AND incubat* AND (framework* OR model* OR design* OR develop*) AND (virtual* OR digital* OR online)`. The number of records resulting from this identification process was 241, and 2 of them were removed for being duplicates. At this point, no other records were excluded, since none of them were marked as ineligible by automation tools, such as Endnote. Next, the following inclusion criteria were applied for screening the records: (i) articles and proceeding papers documents types, peer-reviewed; (ii) from the categories of management, business, computer science theory methods, computer science information systems, economics, computer science interdisciplinary applications, operations research management science, social sciences interdisciplinary, development studies, and multidisciplinary sciences; (iii) published in English, Portuguese, and Spanish languages. Note that no time limitation was applied for screening the records. The resulting sample comprised 152 records, which were then submitted to the VOSviewer software for creating bibliometric networks based on two techniques, namely (i) the bibliographic coupling by documents with a minimum number of 2 citations, which coupled 63 records into 27 clusters; (ii) the co-citation technique, considering a minimum of 6 citations for each record, which reduced the sample to only 22 records categorized into 4 clusters. Given the weak network results obtained with the analytical process and from a complementary bibliometric analysis that revealed similar conclusions (and that the topic under research is relatively new and understudied), it was decided to proceed with the manual selection of the records based on their titles and abstracts. During this process, 116 records were excluded, resulting in 36 reports sought for retrieval. Since it was not possible to retrieve 4 reports, 32 reports were assessed for eligibility, which encompassed their complete reading. During their assessment, 19 reports were excluded for not meeting the research objective and not responding to the research questions, since these reports focused on diverse subjects not related to virtual business incubator models or their operation. Finally, the study screening included 13 reports (concerning 12 studies) as the final sample, and these were qualitatively analyzed in depth. Figure A1 in Appendix A presents the PRISMA flow diagram with the complete process followed during the identification, screening, and selection phases to avoid bias analysis.

### 3. Results

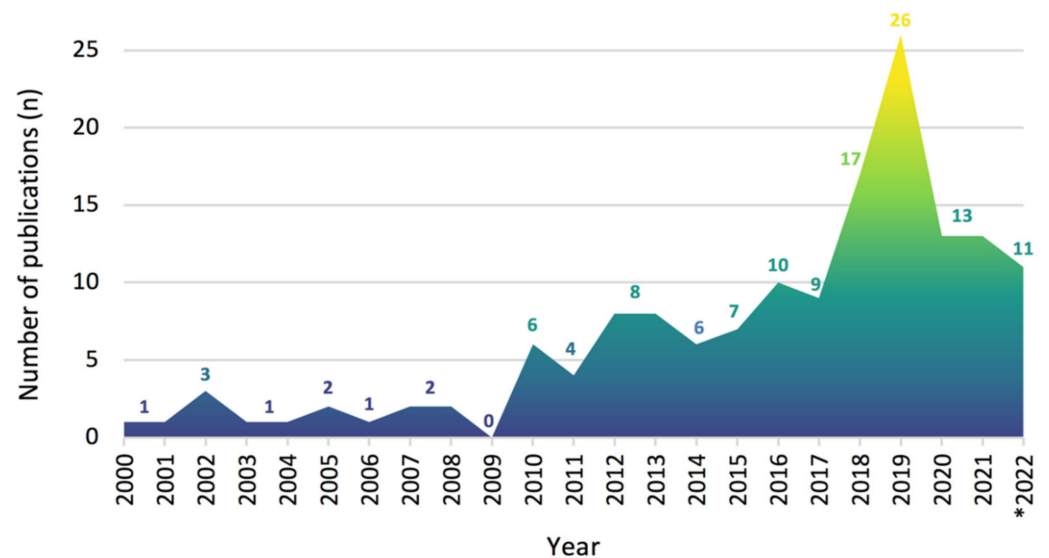
The present section divides into two major subsections to provide a better organized descriptive presentation of the results concerning the following: (i) the bibliometric analysis performed for the records screened, and (ii) the systematic literature review based on content analysis of the reports of the included studies.

### 3.1. Bibliometric Analysis

For the bibliometric analysis, the sample of 152 records screened was considered in order to produce descriptive statistics to gain a better understanding of the scientific production performance and the main sources. Furthermore, it also analyzed the thematic evolution over time according to the records' keywords and the thematic map with the respective clusters.

#### 3.1.1. Scientific Production

Figure 1 presents the temporal evolution and yearly distribution of the scientific records produced by a total of 708 authors.



**Figure 1.** Yearly evolution of the scientific production on digital business incubation models. \* Note: the number of publications of 2022 are estimated based on records published until 1 August 2022.

Since no timespan limit was applied during the screening stage, it is possible to conclude that the first article concerning the theme of virtual business incubation models was published in 2000. However, scientific production was almost inexpressive until the end of 2009, representing 9.2% of the contributions to the field. The publication performance started to improve between 2010 and 2017, corresponding to 38.2% of the total, but it was from 2018 onwards that the highest volume of scientific publications was registered on the Web of Science, i.e., 52.6%. This fact evidences a growing interest in the subject under analysis in the last five years, despite a decrease in the number of records that can be noted since 2020. This notwithstanding, it is important to stress that the presented number of publications for 2022 ( $n = 11$ ) is estimated until 1 August 2022, meaning that this value is subject to increase during the six months ahead until the end of 2022 and will possibly exceed at least the number of publications ( $n = 13$ ) of the last two years (2020 and 2021). Concerning the annual growth rate of publications, the available data allows us to conclude that it was 11.52%, with an average citation per record of 11.

The screened scientific production resulted from authors affiliated with institutions from 62 different countries, and it can be concluded that the United States of America ( $n = 64$ ), the United Kingdom ( $n = 39$ ), India ( $n = 37$ ), Germany ( $n = 34$ ), and China ( $n = 33$ ) were the top five countries with higher scientific production regarding digital business incubator models, representing 29.2% of the global performance. Portugal—the country where the present research took place—appears in the 13th position, with 11 records produced during the last 22 years, corresponding to 1.6% of the contributions to this scientific theme in the Web of Science. Figure A2 in Appendix A, shows a world map with the distribution of scientific production by country.

Notwithstanding the top 5 countries' scientific production performance, it should be noted that the top five of the most cited records belong to the following countries: United States of America ( $n = 578$ ), Netherlands ( $n = 426$ ), Israel ( $n = 127$ ), Spain ( $n = 95$ ), and China ( $n = 95$ ).

### 3.1.2. Main Sources of the Screened Scientific Records

Table 1 presents the top 10 most cited sources of the screened scientific records, distributed according to the number of citations and their corresponding impact factor.

**Table 1.** Top-10 of the most cited sources of the initial screened records ( $n = 152$ ).

Source	Citations ( $n$ )	Impact Factor *
Technovation	171	11.373
Journal of Business Venturing	107	13.139
Research Policy	105	9.473
Strategic Management Journal	63	3.745
Academy of Management Journal	61	10.979
Small Business Economics	56	7.096
The Journal of Technology Transfer	48	5.337
Academy of Management Review	47	13.865
Entrepreneurship Theory and Practice	47	9.993
Harvard Business Review	46	6.87

\* Note: Impact factor according to the 2021 Journal Citation Reports (Clarivate Analytics–2022).

The majority of these sources include leading themes of business, management, technology, and entrepreneurship. Concerning the three most influential sources of scientific information, it can be concluded that *Technovation* is the most cited journal contributing to the field under analysis ( $n = 171$ ), with an impact factor of 11.373. The second most cited source is the *Journal of Business Venturing*, with 107 citations, having a higher impact factor (13.139) than the first source. *The Research Policy* journal was shown to be the third most significant source, with only two citations less than the previous one ( $n = 105$ ), but with a lower impact factor (9.473).

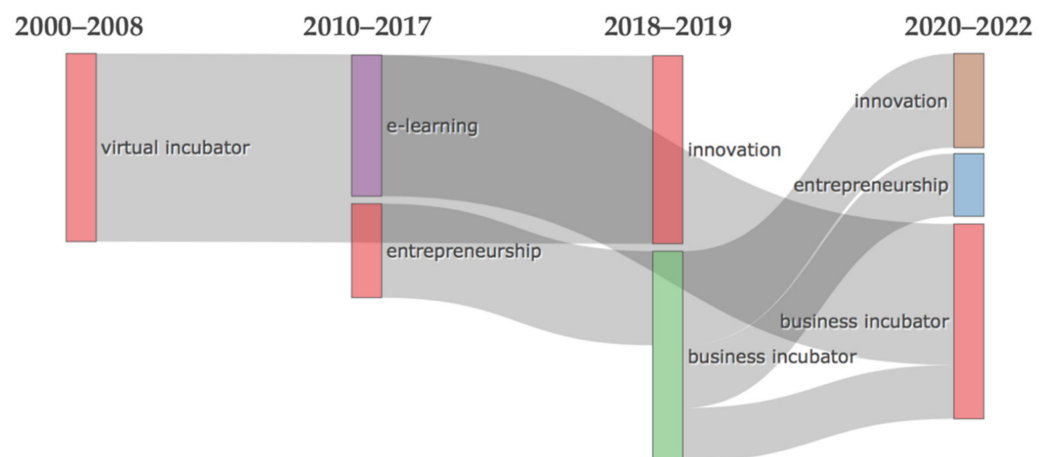
### 3.1.3. Thematic Evolution

To gain an overview of the thematic evolution of the research in the field over time, four timeframes were considered during its analysis, namely 2000–2008, 2010–2017, 2018–2019, and 2020–2022. This approach was followed given the differences previously concluded regarding the scientific production over time instead of dividing the sub-periods into equal time spans.

Figure 2 presents the final output where one, two, or three clusters can be observed for each segmented time period, and the corresponding thematic evolution path resulting from the co-occurrence of the screened records' keywords in each case.

From its analysis, it can be concluded that the main research topic between 2000 and 2008 focused on the "virtual incubator" theme, which came to be part of both the "e-learning" and "entrepreneurship" clusters during 2010–2017. The "virtual incubator" cluster completely dissipated by 2018–2019, showing that researchers stopped developing their studies on this theme and started to focus on "innovation" instead, and also on the "business incubator" theme. The thematic evolution diagram shows that the latter period (2020–2022) is an important milestone in this field of research, as it evolved for the first time into three thematic clusters, namely "innovation", "entrepreneurship", and "business incubator". In this case, both of the "innovation" and "entrepreneurship" clusters emerged from past research (between 2018 and 2019) related to the "business incubator" theme, as well as the new "business incubator" cluster, which started to include the "e-learning" cluster in its core.





**Figure 2.** Diagram of the thematic evolution of the screened records ( $n = 152$ ) between 2000 and 2022.

Despite these three clusters being directly related to what is expected from a digital business incubator, it can be immediately noted from the analysis of the thematic evolution diagram that there is a lack of research concerning the development of conceptual and empirical models or frameworks to support the existence of business incubators in the digital world. This factor indicates, once more, the need for research in this field, not only to advance the academic discussion on how to support global entrepreneurship initiatives based on digital platforms, but also to contribute to better digital practices and strategies that could support innovation while promoting the emergence of new businesses opportunities around the world.

#### 3.1.4. Thematic Map

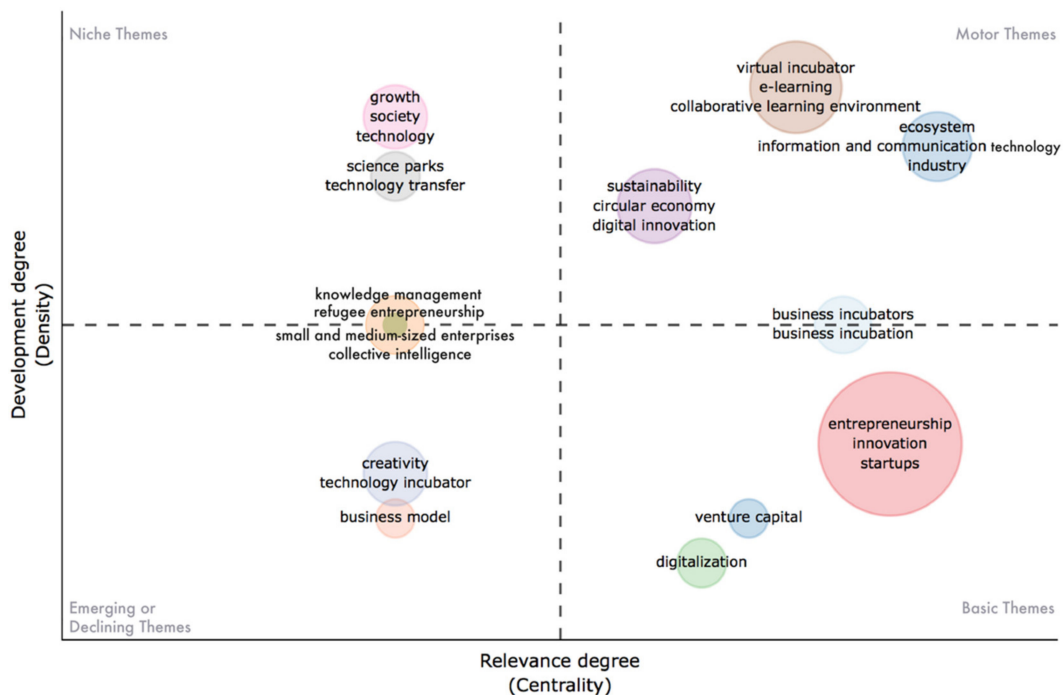
The last step of the performed bibliometric analysis involved the study of the thematic map presented in Figure 3, plotted from the 152 screened records' keywords. This strategic diagram describes the network's morphology from a set of clusters ( $n = 13$ , in this specific case) organized in four quadrants accordingly to their centrality ( $x$ -axis) and density ( $y$ -axis) rank values within the field of study. The distinct sizes of the clusters allow grasping differences in the number of records related to them [27,28]. Since the objective of this phase was to gain an overall understanding of the main themes contributing to developing the research field (instead of the methods followed by the authors during their research), some terms, such as "systematic review" and "case study", were removed to generate the final output, and it was defined that each cluster is labeled accordingly to their top three most recurrent subjects.

The analysis of the thematic map allows for the following conclusions:

- Three clusters in the upper-right quadrant represent the motor themes related to the field of virtual business incubators models, meaning they have central importance in the progress of this research field. These clusters include the following themes: "virtual incubator", "e-learning", and "collaborative learning environment"; "ecosystem", "information and communication technologies", and "industry"; and "sustainability", "circular economy", and "digital innovation".
- Three clusters in the lower-right quadrant have high centrality but are not well-developed, representing basic and transversal themes, namely "entrepreneurship", "innovation", and "startups", "venture capital", and "digitalization".
- Two clusters in the upper-left quadrant, related to "growth", "society", and "technology"; and "science parks" and "technology transfer", have very specialized and well-developed themes, with strong connections between them but with only marginal importance for advancing this field of research.
- Two clusters in the lower-left quadrant have both low density and low centrality, meaning that the themes concerning "creativity", "technology incubator", and "busi-

ness model” have the potential to turn themselves into emerging themes, which could be determinants of the future development of this research field.

- Three other clusters emerged from the thematic map, having the same density but almost opposed centrality. The location of the cluster with the themes “business incubators” and “business incubation” allows us to draw conclusions about their importance for the research field, although they are not well-developed yet and deserve more attention in the future. On the left side, the two overlay clusters containing the themes (1) “knowledge management” and “collective intelligence”, and (2) “refugee entrepreneurship” and “small and medium-sized enterprises”, tend towards niche themes that could also be further explored to advance the research of digital business incubator models.



**Figure 3.** Thematic map with the characterization of the 13 clusters resulting from the screened records ( $n = 152$ ).

### 3.2. Systematic Literature Review Based on Content Analysis

The present section focuses on the performed systematic literature review based on the content analysis of the 13 reports of the screened studies. As mentioned before, it intends to explore the dimensions through which virtual business incubation models operate and how they support their tenants during the creation and development of their business.

To try to simplify the performed analysis, Table 2 presents a synthesis of the main findings related to each study concerning the following aspects: the authors; the study’s country and year; the main industries, businesses, or society that each virtual business incubator relates to; the methods followed by authors to propose each model; and the dimensions in which they are organized to support the digital incubation of tenants. Next, the reviewed virtual business incubator models will be presented and addressed in detail.

**Table 2.** Systematization of the main features of studies included in the systematic literature review.

Authors	Study's Country and Year	VBI's Main Industries/Business/Society	Study's Methods	VBI Model's Dimensions for Digital Incubation
Nowak and Grantham [29]	United States of America, 2000	Software industry	Case study	<ul style="list-style-type: none"> <li>- Integrated human resources and capital</li> <li>- Focus on strategic alliance formation</li> <li>- Intellectual capital valuation and management</li> <li>- Internet-based</li> <li>- For-profit</li> <li>- Private sector plays leading role</li> <li>- Formalized management control systems</li> <li>- National and international business and market</li> <li>- Work with physical incubators when needed</li> </ul>
Tzafestas [30]	Greece, Italy, France, Czech Republic 2008	Social economy	Case study	<ul style="list-style-type: none"> <li>- Provision of initial capital</li> <li>- Knowledge and training</li> <li>- Mentoring</li> <li>- Support services</li> </ul>
Joita, Carutasu, and Botezatu [31]	Romania, 2010	Emergent economic agents (not specified)	No data available	<ul style="list-style-type: none"> <li>- Knowledge management system</li> <li>- Three-tier client–server architecture</li> <li>- Segmentation of users based on their needs</li> <li>- Content, support, and networking restrictions/adjustments, depending on price</li> </ul>
Guetl and Pirker [32,33]	Austria, 2011, 2012	n/d	Questionnaires	<ul style="list-style-type: none"> <li>- Virtual 3D worlds</li> <li>- Knowledge</li> <li>- Social contacts</li> <li>- Resources and infrastructures</li> </ul>
Ciocoiu, Colesca, Pacesila, and Burcea [34]	Romania, 2014	e-Waste, recycling, and eco-innovation	Questionnaires ( $n = 43$ )	<ul style="list-style-type: none"> <li>- Knowledge and training</li> <li>- Local, national, and international events</li> <li>- Innovation, knowledge, and technology transfer</li> <li>- Access to funds</li> </ul>
Unal, Afsarmanesh, and Angelov [35]	Netherlands, 2014	Virtual organizations	Literature review	<ul style="list-style-type: none"> <li>- Innovation process</li> <li>- Competence matching</li> <li>- Trustworthiness evaluation</li> <li>- Negotiation support</li> <li>- Performance evaluation</li> </ul>



Table 2. Cont.

Authors	Study's Country and Year	VBI's Main Industries/Business/Society	Study's Methods	VBI Model's Dimensions for Digital Incubation
Agostinho, Lampathaki, Gonçalves, and Lazaro [36]	Portugal, Greece, and Spain, 2015	Virtual organizations	Literature review	<ul style="list-style-type: none"> <li>- Market sensing</li> <li>- Unified digital enterprise</li> <li>- Financing</li> <li>- Team building</li> <li>- Product support</li> <li>- Mentoring</li> </ul>
Elia and Margherita [37]	Italy, 2016	Technology entrepreneurship	No data available	<ul style="list-style-type: none"> <li>- Actors in the ecosystem</li> <li>- Activities performed</li> <li>- Knowledge assets and flows</li> <li>- Environment containing the services available</li> </ul>
Tawil, Halim, Ramlee, and Arsad [38]	Malaysia, 2016	Local entrepreneurs (varied business types)	Literature review	<ul style="list-style-type: none"> <li>- Entrepreneurs, agencies, and startup/enterprises profiles</li> <li>- Online business simulation</li> <li>- Access to funding opportunities</li> <li>- Incubator provider</li> </ul>
Stevenson [39]	Finland, 2017	Education technology (EdTech) industry	Case study	<ul style="list-style-type: none"> <li>- Participants</li> <li>- Demo path and second Lab</li> <li>- Knowledge and training</li> <li>- Mentoring</li> <li>- Networking</li> </ul>
Luik, Ng, and Hook [40]	United Kingdom, 2019	Creative industry	<ul style="list-style-type: none"> <li>- Website analysis to categorize virtual hubs (<math>n = 25</math>)</li> <li>- Semi-structured interviews with virtual hub organizers (<math>n = 7</math>) and participants (<math>n = 3</math>)</li> </ul>	<ul style="list-style-type: none"> <li>- Participants</li> <li>- Virtual incubator business model</li> <li>- Key qualities</li> <li>- Program organization</li> <li>- Support offered</li> <li>- Duration of support</li> <li>- Digitalization strategies</li> <li>- Information and communication digital tools</li> </ul>
Harima, Periac, Murphy, and Picard [41]	Germany, France, and Ireland, 2020	Refugee entrepreneurship (varied business types)	Semi-structured interviews with refugee entrepreneurs ( $n = 50$ )	<ul style="list-style-type: none"> <li>- Value creation in homeland resources</li> <li>- Transnational middleman minority</li> <li>- Integration facilitation</li> <li>- Qualification transfer</li> <li>- Solving homeland problem</li> <li>- Creative innovation</li> </ul>

Note: virtual business incubator (VBI).

The first reviewed publication proposing a virtual business incubator model [29] was authored by Nowak and Grantham in the United States of America, back in 2000, and was developed based on a case study of the software industry in California. This model aimed to enhance the development of sustainable competitive advantages and facilitate the access of the small business community to information on best practices for business development, industry and management experience, and resources for international marketing, sales, and distribution.

It is organized in nine dimensions, with the first one focusing on integrating human resources and capital beyond their geographic location. It concentrates on strategic alliance formation, bringing all essential ingredients for success together as early as possible, such as technical and business talent across all frontiers, to promote wealth creation and new business opportunities. In this model, intellectual capital valuation and management expertise are both on-board and active from the start, and the resources are distributed on internet-based platforms.

The authors expect virtual business incubators to be private and for-profit, making money by acquiring equity in their tenant's companies or through services provided to them. In this scope, the private sector plays a leading role, while universities and the public sector have supporting roles. The focus is mainly on national and international business and markets. The last two recommendations would be to have a formalized management control system for stability, such as accounting, and to work in partnership with physical incubators whenever needed.

The virtual business Incubator DYEKO [30] was Id within the scope of the EQUAL European project to promote Greek women's entrepreneurship in the social economy. This incubator operates in a four dimensional model encompassing the following: the provision of initial capital, knowledge and training, mentoring, and a set of support services.

When entering the virtual incubation program, the pilot enterprises were given initial capital to start their business. Tenants also have access to knowledge exchange and training concerning good practices in the operation of social economy enterprises. Given the European Consortium between Greece, Italy, France, and the Czech Republic, entrepreneurs have the opportunity to be involved in several joint actions from these countries, namely workshops, educational visits, working in groups, and experience sharing. The incubator also offers them fundamental educational material on the social economy, informatics, and related topics.

Furthermore, tenants have access to proper mentoring for starting their social enterprises and are offered a set of support services to help in its development, such as advice and help in marketing, accounting, taxation, insurance, banking and finances, and legislation actions.

On the other hand, Joita, Carutasu, and Botezatu [31] propose a virtual business incubator model to support emergent economic agents in Romania. This model is structured as a knowledge management system (KMS) using a three-tier client-server architecture, in which the participants contribute with their experience, and a team of experts periodically validates the presented processes. The model's data infrastructure operates in three layers, namely data, information, and knowledge.

The data layer comprises several aspects—such as business opportunities, funding opportunities, national policies, networking, and technology transfer, among others—and is provided as information aggregated by subject (in teleworking groups, commerce and industry chamber, or others), depending on the users' segmentation. Finally, the knowledge layer involves the knowledge discovery processes by the user and is assisted by prediction processes to present reports based on scenarios derived from the users' acquired knowledge.

This model operates according to the user's segmentation, meaning that all tenants should be able to have access to the same subjects. However, a variation in the price provides different levels of detail, quality, and richness of content, as well as restricted access to virtual incubator tools, depending on the subscribed incubation version. The same applies to support services—which are adjusted according to the tenants' needs, both in

terms of price and frequency of access to experts—and also to access cooperation directories and networking.

The business Incubator model designed by Guetl and Pirker [32,33] was proposed under the European CBVI (cross border virtual incubator) project, developed in Austria, following an iterative approach and questionnaires data analysis. The researchers implemented the proposed model in a virtual 3D world to support three different dimensions, namely knowledge, social contacts, and resources.

The knowledge dimension allows tenants to learn about specialized subjects alone or in groups during lectures and training sessions or by working with experts. This module is supported by collaborative e-learning tools, virtual seminars and workshops, sharing resources, and competence training through role-playing games.

The social network dimension allows collaborative group activities during which users can meet and discuss ideas with peers and experts, and where they can present their business plans and entrepreneurship ideas to the community. Tenants can also get in touch with potential investors during organized virtual events. These activities aim to simultaneously support social interaction, network creation, and knowledge acquisition. The model also supports a virtual café to promote social interaction among users.

The third dimension—resources and infrastructures—seeks to enable start-ups to use a virtual presentation space where they can create their own content for marketing purposes. It is also possible to design their own virtual office.

Aiming to develop a virtual hub for eco-innovation in the field of electrical and electronic equipment (e-waste) recycling, Ciocoiu, Colesca, Pacesila, and Burcea [34] conducted a questionnaire in Romania and proposed a model based on the considerations and requirements of 43 experts from universities and research and development institutes. The virtual eco-innovation hub aims to promote business, academic, and research opportunities, and is organized in a model with four principal dimensions, namely knowledge and training, access to national and international events, innovation, knowledge, and technology transfer, and access to funds.

Tenants would have access to specialized knowledge, technical assistance, advice, training, and debates through online interactive sessions, concerning priority topics for the sector, such as specific legislation, management policies, and techniques and modern technologies for recycling, among others. It is also expected that the virtual incubator would support access to local, national, and international events to strengthen cooperation among hub members, foster collaboration among the various actors involved in the field, and help and encourage access to funds to support eco-innovation businesses. Another dimension of the proposed model would be to facilitate the direct transfer of knowledge and technology for innovation and to promote the dissemination and exploitation of results obtained during the project's development.

Unal, Afsarmanesh, and Angelov [35] developed an agile innovation framework to help guide entrepreneurs and small and medium enterprises (SMEs) of virtual organizations through the innovation process, providing them assistance on what to do at each step and which tools or mechanisms to use. This model is based on a virtual organization breeding environment, meaning that entrepreneurs, SMEs, production and delivery companies, and financial institutions are all members of the same business incubator involved in the innovation process.

The authors divide the innovation process into sixteen steps, including, among others, the business definition and market research, draft solution design, required competency definition, virtual organization creation, detailed solution design, testing, and commercialization.

During this journey, tenants can be assisted by automation tools to facilitate the creation and operation of their business. These help during the competency matching and potential partners identification stage to facilitate the rapid formation of virtual organizations. Additionally, the trustworthiness evaluation feature performs competence matching and presents a list of potential members refined based on their trustworthiness. The proposed framework also has the potential to facilitate negotiation rounds through

collaboration tools, such as chatrooms and forums, where potential members can discuss diverse subjects. Finally, the performance evaluation tool aims to continuously monitor and measure the operation life cycle of the business and presents tenants with a set of key performance indicators.

Aiming to support and drive entrepreneurs during the creation of their business idea, Agostinho, Lampathaki, Gonçalves, and Lazaro [36] proposed a virtual business incubation model to operate for a nine-month period, consisting of an online platform organized in six dimensions, namely market sensing, unified digital enterprise, financing, team building, product support, and mentoring.

Market sensing makes use of crowd-mining approaches to analyze and monitor the market, helping in the identification of business opportunities. The second module—unified digital enterprise—supports the planning and update of the business plan along its entire lifecycle by applying modeling technologies to keep the information up to date. The financing dimension enables interconnectivity with banking platforms, including crowdfunding opportunities and online pitch presentations to potential investors and advisors participating in a European online network. Moreover, the proposed model fosters dynamic partnering and collaboration among users and organizations with complementary objectives, providing a team-building area with an intelligent selection of potential human resources to collaborate with. The platform would also support tenants and enterprises during the product development and prototype phases, although not much detail is given about how this operates. The last dimension—mentoring—concerns remote personal assistance, facilitated by advisors in the network, to provide tenants and digital organizations with support during the entire process.

The model of the entrepreneurial information system eGosystem, described in the work of Elia and Margherita [37], aims to provide entrepreneurs with the appropriate conditions and resources to start a technology entrepreneurship project. It is organized into four main components, namely actors in the ecosystem, activities performed, knowledge assets and flows, and the environment containing the services available.

Actors in the ecosystem can interact together to share competencies and experiences while having access to a set of formal and informal knowledge resources that can support their overall entrepreneurial process, such as learning resources, virtual meetings, multimedia content, blogs, wikis, chatrooms, project management suites, reports, web pages, and links. It is expected that each tenant will acquire knowledge and perform activities related to the following three stages: the desk stage (scenario scanning, opportunity recognition, concept definition and value proposition, revenue model and value capture, and detailed business planning); the pre-market stage (funding and capital raising, sourcing and team organization, intellectual property and legal formation, product and service development); and the market stage (operations management, profit and harvesting, and venture expansion and development).

Apart from educational and business development dimensions, the digital platform environment also integrates several categories of services to also guarantee the collaborative and individual support of tenants, such as skills-gap analysis, monitoring and reporting, partner discovery, collaborative laboratories, and virtual pitches, among others.

Despite the proposed dimensions, the authors call attention to the fact that it is pertinent for virtual incubators to develop key elements to create a sustainable entrepreneurial ecosystem among the diversity of stakeholders, mentioning informal networks, links with universities, capital services, and other professional and support services as crucial ones for knowledge management and collaboration/socialization business incubation platforms.

With the intent to provide business training to entrepreneurs from Malaysian startups, small and medium enterprises, agencies, and researchers, and help them to build collaborative social and industry networks quickly, Tawil, Halim, Ramlee, and Arsad [38] developed an online portal system named Entreportfolio. The model of this strategized system operates based on four interconnected dimensions, namely users' profiles, online business simulation, access to funding, and the incubator provider.

The platform supports diverse users (single entrepreneurs, small and medium enterprises, startups, researchers, or agencies) to include and present information linked to their businesses and the activities they run in their profiles. Any actor involved in this online ecosystem can search for others and establish a network of cooperation. It also fosters the spread of information about funding opportunities and supports users to obtain faster fundraising for their business through this online medium.

Another dimension is the online business simulation area, which serves as a business development training scheme to improve the user's skills and education related to operations, marketing, and finances. This happens through individual training of entrepreneurs, access to interactive courses, and serious games.

In addition, physical incubators contribute with equipment, office areas, or other necessary facilities to complement the virtual model. If needed, it is possible to search for information about the incubators connected to the platform and to get to know about the needed infrastructures or equipment they can provide.

The Oulu EduLAB [39] is a permanent university-managed incubation program in Finland, focusing on entrepreneurship education, digital product prototyping, business development, and startup creation, targeting the global education technology (EdTech) industry. Although this model follows a hybrid approach (virtual and physical), it was considered in the present systematic literature review for its different approach. It operates based on five dimensions, namely participants, demo path and second lab, knowledge and training, mentoring, and networking.

Participants are required to be enrolled in the last years of bachelor's or master's national or international degree programs to apply to enter the Oulu EduLAB or be unemployed professionals undertaking in the scheme in order to retrain.

The program is structured as two parts, each five months long (one semester). The first lab is called the "demo path" and involves the creation of interdisciplinary and international teams to produce a working digital prototype (e.g., a mobile application, educational game, e-books, among others), conduct initial user testing, and develop a draft of their business plan. After completing this phase, teams enter a second lab to continue the development of their project toward a minimum viable product and establish a startup.

During the incubation, tenants are exposed to expanding their network and partnering with local, national, and international companies working in the EdTech sector and collaborating with them to develop products to solve identified problems. Teams also have constant access to activities and programs to enhance their knowledge and training, being mentored by coaches (virtual or face-to-face) to support their project work, develop the team, and help during the business creation.

More recent research [40] conducted in the United Kingdom was aimed at understanding the structural form of creative virtual hubs, their diverse incubation processes, and at categorizing the range of support they offer to their tenants. The authors followed a two-stage research process, which involved identifying and categorizing 25 virtual creative hubs based on the information provided on their websites and then conducting semi-structured interviews with 7 virtual hub organizers and 3 participants to explore their experiences in detail.

They concluded that the virtual hubs in their study have the potential for international scalability, having taken advantage of being virtual to increase participant numbers and diversity, despite their geographical locations, as they accept individual or group participants with diverse business focuses and at different stages of business development.

Regarding the participation fee, virtual business incubators offer a free or cheaper participation cost, depending on their business models; some hubs follow a business-to-customer (B2C) model to sell their programs and services directly to entrepreneurs; others adopt a business-to-business (B2B) model to provide a digital platform to enable other institutions (corporations, government, foundations, physical incubator hubs, or universities) to deliver their own incubation or acceleration program, and some virtual incubators provide platforms that can simultaneously serve both approaches. Concerning the participant-



incubator interaction, some provide their programs and services entirely online, while others adopted a hybrid approach, mixing online and in-person interactions. As key qualities used to describe their activities, the provision of knowledge exchange to their participants was the most common (96% of the analyzed hubs), followed by the incubation process (76%), and the expansion of social capital of their users (46%) by providing them access to specialized information and know-how.

The creative virtual hubs included in the study followed different organizational strategies to effectively conduct their programs, namely using pre-session activities to select suitable and motivated applicants; mentor–participant matchmaking; provision of customized sessions and content; building gamification into their digital platforms and applying motivational techniques to support engagement during the virtual process; providing online group channels to encourage communication among participants; promoting boot camps and demo days; and employing progression meeting points.

Among the support offered to their tenants, it was concluded that virtual hubs included the following: learning resources, mentoring and long-term mentorship, seminars and workshops, funding advice, demo days, networking connections, access to investors, training, legal and accountancy support, direct funding, investment readiness, access to experts, and technological support. The duration of the offered support is variable and not consensual, ranging from up to 3 months (28%) to 10 months or greater (8%), while in 44% of the cases the duration was not specified.

These activities are digitalized to replicate spaces for interactions as found in in-person incubator hubs, and virtual hubs commonly use the following information and communication tools: video conferencing for one-on-one and group meetings, group messaging, shared documents, digitalization of business model canvas and financial projection, learning management systems, and customized software.

Different from the discussed models' approaches, Harima, Periac, Murphy, and Picard [41] developed their research to offer entrepreneurship education and support entrepreneurial opportunities for migrant citizens in Europe under the scope of the Erasmus+ VIFRE (virtual incubators for refugee entrepreneurs) project. The proposed model was developed based on the results of semi-structured interviews with 50 refugee entrepreneurs who participated in business incubation programs in Germany, France, and Ireland. It focuses on fostering six types of business opportunities, namely value creation in homeland resources, the transnational middleman minority, integration facilitation, qualification transfer, solving homeland problems, and creative innovation.

The creation of value with homeland resources applies to the food and cultural industry, for instance, to sell products or services. It implies testing and validating ideas with potential customers and contacting external organizations to expand their networks, among other proactive actions.

On the other hand, the transnational middleman minority requires transnational contexts to connect the interest of stakeholders in different locations (homeland and host countries). In this regard, trading activities to import and export products, tours organization and investment facilitation services need to be developed.

The integration facilitation dimension of the virtual incubation model aims to support businesses related to services to help the integration process of refugees. These business opportunities are related to workshops, sports, and cultural activities organization; assistance in finding job opportunities, and workshops to enhance literacy.

Another entrepreneurial value-creation opportunity is qualification transfer, in which tenants could transfer their tacit knowledge (e.g., industry and metal recycling experience, design, and real estate experience) to their host countries. This requires understanding the demands of the host country, identifying if the human capital could apply there, and validating the market potential.



The fifth value-creation dimension concerns solving homeland problems based on past personal experience. It mainly assumes a prominent social entrepreneurial character, where entrepreneurs try to develop solutions to similar problems to those they faced in their home countries.

The last dimension is the development of businesses based on creative innovation through human capital that can be applied to the global market, such as tourism agencies with virtual reality, solutions for children's safety, and art education, for example. Therefore, apart from understanding the host market and identifying its demand, entrepreneurs need to apply their unique human capital to construct innovative business opportunities.

The findings concerning the presented virtual business incubator models will now be discussed.

#### 4. Discussion

The discussion about the main findings and implications concerning the research results is organized into subsections accordingly to the three research questions that guided the present study.

##### 4.1. How Has Academic Research concerning Virtual Business Incubators' Development Evolved?

The results derived from the performed bibliometric analysis of the 152 records initially screened from the Web of Science database revealed that academic production related to the field under study is incipient and not well developed. Although the first article concerning the theme of virtual business incubator models was published in 2000, it was only from 2018 onwards that more than half of the volume of scientific publications was registered (52.6%). These findings are corroborated by the conclusions of several authors [13–17], who explain that “studies on incubator business models remain embryonic” [13] (p. 92), either relating to physical or virtual modalities, given that “only recently, research focusing primarily on the phenomenon of business incubators themselves gained traction” [14] (p. 152).

Moreover, from the output of the bibliometric networks produced based on the bibliographic coupling of documents and the co-citation techniques, it was concluded that the literature in this field is fragmented and develops under a variety of perspectives and research lines, having only a few common references at their basis. This conclusion is also supported by [14] (p. 152) when mentioning that the “literature appears to remain fragmented and incubators have long been studied mostly as a peculiar phenomenon”.

Regarding the thematic evolution, research until 2017 focused mainly on the virtual incubator, e-learning, and entrepreneurship subjects, while more recent studies relate virtual business incubator models to innovation, entrepreneurship, and business incubation.

Finally, the thematic map revealed that 13 clusters describe the network's morphology and that 3 clusters have had central importance in the development of the field, including themes, such as virtual incubator, e-learning, and collaborative learning environment; ecosystem, information and communication technologies, and industry; and sustainability, circular economy, and digital innovation. Which of these clusters are more influenced or supported by different types of policies could be an object of attention in further studies.

##### 4.2. Which Virtual Business Incubator Models Exist, and How Do They Organize to Support Their Tenants with Business Creation and Development?

Two aspects should be immediately stressed from the performed systematic literature review about virtual business incubator models. First, the low number of included studies concerning the research undertaken ( $n = 12$ ) clearly evidences the lack of research on this specific topic. The performed systematic literature review revealed that the vast majority of the reports assessed for eligibility focused on diverse subjects not related to virtual business incubators models or their operation. Second, none of the reviewed studies followed a systematic literature review to propose their virtual incubation models, which demonstrates the need to carry out the present research. The main study methods followed by authors

were case studies (25%), non-systematic literature reviews (25%), questionnaires (16.7%), semi-structured interviews (16.7%), and website analysis (8.3%).

Moreover, it can also be concluded that there is not a unified model to support virtual business incubators' operation during the digital incubation of their tenants, though the verified examples show a tendency to not depend on physical infrastructures or geographical locations for their functioning, typically. The operational dimensions tend to vary largely depending on the industries, business, or society areas where the entrepreneurs develop their businesses, but some dimensions were found to be in common in some of them.

The most usual dimension in all the reviewed models relates to business and innovation knowledge acquisition and training of the tenants for the entrepreneurship world through using diverse information and communication technology solutions as mediums to support workshops, seminars, lectures, learning resources, and group activities, among others. The second most common dimension, supported by 66.7% of the reviewed models, concerns the provision of organized networking opportunities and internal and external partnership creation, bringing together tenants from the same virtual incubator and external agents, such as associations, organizations, universities, enterprises, or other stakeholders involved in the incubator. Half of the reviewed virtual incubators also offer support services to their tenants to help during the creation of startups or business development, although their availability, access, and cost are variable in some cases, depending on the tenants' profile, business stage, or segmentation. Additionally, 50% of the virtual incubators are also focused on promoting financing opportunities and facilitating information about funding access, for instance, through organizing virtual events with investors, allowing interconnectivity with financing institutions, and participating in crowdfunding platforms. Another common dimension found in 33.3% of the incubators' models was the facility to access expert mentors and advisors to support the tenant's business creation process, although these sessions could sometimes happen online or face-to-face.

Additionally, during the systematic literature review, it was noted that the authors proposed the diverse virtual business incubator models from three perspectives, namely the business organization and management perspective, the information and communication systems perspective, and the user experience and engagement perspective. Table 3 presents a synthesis of these findings, from which it is possible to conclude that the most common perspective was the organization and management perspective, present in 91.7% of the models. Next, the information and communication systems perspective was present in 58.3% of the models, while only 25% of the proposed models took into account the perspective of user experience and engagement during the virtual incubation process. These results also reveal that only two of the proposed models (16.6%) took into account all three perspectives, and that 33.3% of them were developed based on both viewpoints of business organization and management and information and communication systems. Lastly, 41.7% of the proposed models were solely grounded on the perspective of virtual business incubators' organization and management, and one model followed both perspectives related to information and communication systems and user experience and engagement.

**Table 3.** Perspectives of the virtual business incubation models resulting from the systematic literature review.

Authors	Organization and Management Perspective	Information and Communication Systems Perspective	User Experience and Engagement Perspective
Nowak and Grantham [29]	X	—	—
Tzafestas [30]	X	—	—
Joita, Carutasu, and Botezatu [31]	X	X	—
Guettl and Pirker [32,33]	—	X	X

Table 3. Cont.

Authors	Organization and Management Perspective	Information and Communication Systems Perspective	User Experience and Engagement Perspective
Ciocoiu, Colesca, Pacesila, and Burcea [34]	X	—	—
Unal, Afsarmanesh, and Angelov [35]	X	X	—
Agostinho, Lampathaki, Gonçalves, and Lazaro [36]	X	X	—
Elia and Margherita [37]	X	X	—
Tawil, Halim, Ramlee, and Arsad [38]	X	X	X
Stevenson [39]	X	—	—
Luik, Ng, and Hook [40]	X	X	X
Harima, Periac, Murphy, and Picard [41]	X	—	—

#### 4.3. Which Virtual Business Incubator Model Is More Suitable to Support the Process of Digital Businesses or Startups Creation?

Regarding the third research question, the results from the conducted systematic literature review do not allow us to conclude which model is most suitable to support the incubation process to help tenants during their digital business or startup creation.

In fact, as already discussed, the undeveloped research and the fragmentation of the existing knowledge related to this field make it challenging to identify a unified model that could guide and support managers, academics, organizations, and other interested professionals in undertaking a successful path of creating and running a virtual business incubator.

Given this reason and aiming to contribute to the development of the research field, the next steps of this research project will focus on creating a unified model for virtual business incubators. The main findings deriving from the conducted systematic literature review will be taken into account to convey all previously identified perspectives, i.e., business organization and management, information and communication systems, and user experience and engagement. Moreover, a participatory design approach will be followed to co-design and continuously improve the unified model, namely (i) by interviewing tenants from incubators to understand their needs and expectations during the incubation process, and (ii) by organizing focus groups with several incubators' experts in different moments, to iteratively validate or re-design the virtual business incubator model.

## 5. Conclusions

Virtual business incubators have the potential to foster entrepreneurship and innovation in several business areas and on a worldwide scale, contributing to global economic growth and social development. However, the phenomenon related to these incubators, their value creation, their impacts, and especially their business models is still in the embryonic stage of academic research.

This study set out to conduct a bibliometric and systematic literature review concerning virtual business incubator models, with the main objective being to shed light on the evolution of academic research in this field, the existing models and how they organize and operate to support tenants during creation and development of their businesses, and on understanding which virtual incubator model is more suitable to support the process of digital business or startup creation.

From the performed bibliometric analysis, it was concluded that academic production related to this field is relatively new, scarce, and not well developed. Additionally, fragmentation of this field of knowledge was observed, which tends to develop under a diversity of

academic perspectives and research lines, with recent studies focusing on virtual business incubator models linked to innovation, entrepreneurship, and business incubation aspects.

As a result of the systematic literature review, it was concluded from the analysis of 12 virtual business incubator models that, generally, these incubators do not depend on the physical infrastructures or geographical locations of their tenants for their functioning. However, the main conclusions were that there is not a unified model to support virtual business incubators' operation during the entire incubation process of their tenants, and that authors tend to propose diverse models through three different perspectives, namely the business organization and management perspective, the information and communication systems perspective, and the user experience and engagement perspective. Another important conclusion was that the models' operational dimensions tend to vary largely depending on the industries, business, or society areas linked to the developing businesses. This notwithstanding, some dimensions were found to be in common in some of the analyzed models, as follows: business and innovation knowledge acquisition and training; provision of organized networking opportunities and partnership creation; provision of support services to help tenants' ideas or business development; promotion of financing opportunities and related information; and facilities to access expert mentors and advisors.

Given these reasons, it was considered necessary to design a further conceptual model based on the results and the main findings derived from the conducted research, towards the unification of virtual business incubator models. This model should take into account the diverse academic perspectives identified and be organized in dimensions to support the entire program operation. Hopefully, the development of a unified model that could be replicated in a diversity of contexts would offer guidance and support to managers, academics, organizations, and other professionals interested in undertaking a successful path of creating and running a virtual business incubator.

Several limitations of this research should also be mentioned. Despite the reduction in the unconscious bias deriving from a systematic review, when compared to non-systematic reviews, this methodology presents several limitations, *per se*. The screening process was limited to the records found exclusively in one database. Although the Web of Science database is recognized as one of the most comprehensive in management science-related topics, it is not exhaustive, meaning that some relevant publications only covered by other databases were not included in this research. Additionally, the carefully discussed and selected search terms can also introduce bias to the data collection process and consequently to the systematic review, so the followed methodology cannot be understood as covering the field of study analysis exhaustively. Moreover, it was only selected records written in English, Spanish and Portuguese during the screening process, which is another source of bias in this research. Future research studies could follow the same methodology but use other databases and a broader inclusion criterion during the records screening to draw state-of-the-art conclusions in this particular field.

Another important limitation to note is that the researched virtual business incubator models were mainly based on the articles resulting from the systematic literature review, lacking at this point a unification of the perspectives and validation of actual incubator managers, directors, entrepreneurs, startup founders, and other incubation organizers. Nevertheless, this article can be used as a starting point for further research and can be enhanced based on the assessment and contributions of the several incubator stakeholders. A suggestion would be to adopt a design-based research methodology involving the different stakeholders in order to iteratively test, improve, and co-create a future version of a virtual business incubator model. It is expected that a model, such as this one, would serve vast business areas and support a multiplicity of entrepreneurs, contributing to generating more innovative and inclusive entrepreneurship while ensuring the sustainable development and growth of stronger digitally-based businesses.

Lastly, it is stressed that the research findings of the present article have theoretical and practical implications, which are believed to be beneficial to managers, entrepreneurs, professors, researchers, students, and policymakers, as well as other professionals working in this field.

**Author Contributions:** Conceptualization, R.V., J.V.d.C. and S.F.T.; methodology, R.V., J.V.d.C. and S.F.T.; validation, R.V., J.V.d.C. and S.F.T.; formal analysis, R.V., J.V.d.C. and S.F.T.; investigation, R.V., J.V.d.C. and S.F.T.; resources, R.V.; data curation, R.V.; writing—original draft preparation, R.V.; writing—review and editing, R.V.; supervision, R.V., J.V.d.C. and S.F.T.; project administration, J.V.d.C. and S.F.T.; funding acquisition, J.V.d.C. and S.F.T. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by FCT—FUNDAÇÃO NACIONAL PARA A CIÊNCIA E A TECNOLOGIA, grant number UIDB/05422/2020.

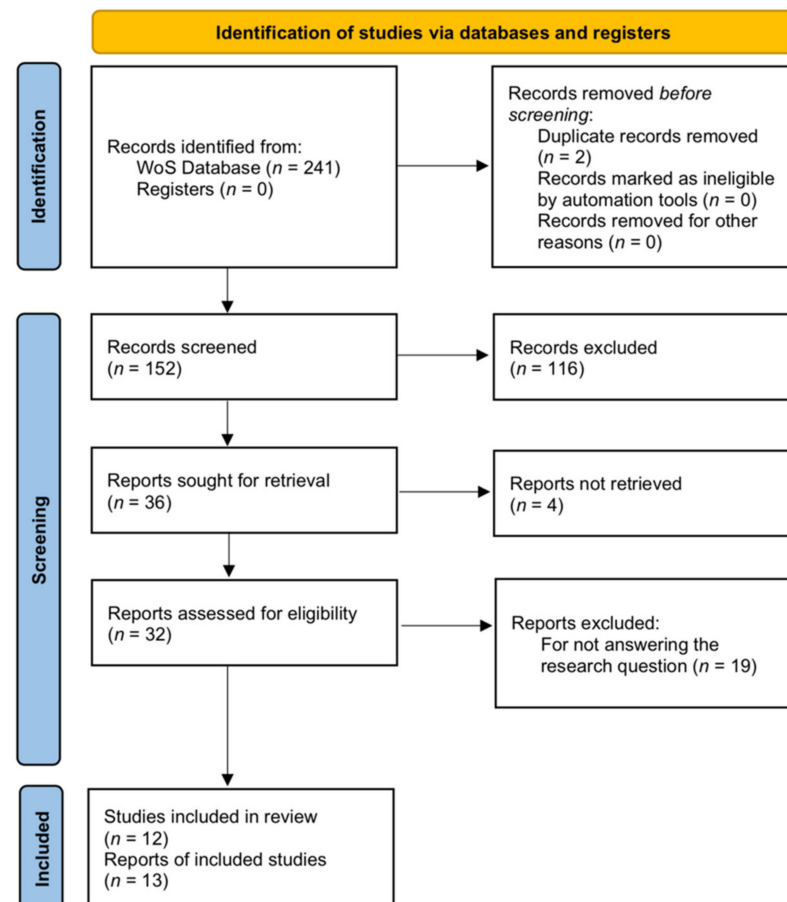
**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

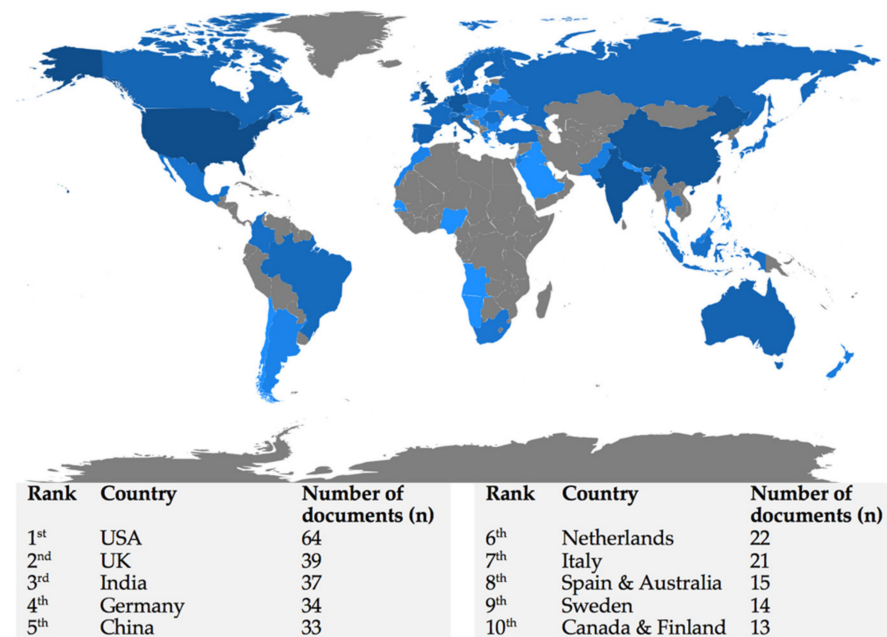
**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

## Appendix A



**Figure A1.** PRISMA 2020 flow diagram of the systematic literature review.



**Figure A2.** Scientific production by country (darker shades of blue represent higher productivity than lighter shades of blue, and the grey color represents no articles).

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