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Review

A Systematic Literature Review of Partnership Development at the University–Industry–Government Nexus

Mike Burbridge * and Gregory M. Morrison

Curtin University Sustainability Policy Institute, School of Design and the Built Environment, Curtin University, Perth 6102, Australia; greg.morrison@curtin.edu.au

* Correspondence: mike.burbridge@postgrad.curtin.edu.au

Abstract: The increasingly entrepreneurial intent of universities implies the commercialization of knowledge and innovation through the triple helix of interactions between universities, industry and government. However, there remains a lack of clarity concerning best practice partnerships for innovation. This systematic literature review (SLR) provides insights onto the development of partnerships at the university–industry–government nexus and builds on the existing top-down/bottom-up approach for the creation of intermediaries of innovation. The SLR describes the evolution of these intermediaries, which is driven both by criteria set by partners and the globalization of the knowledge economy. This SLR reveals that the partnership structure most likely to further economic and broader societal goals is the living lab with the inherent focus on open innovation and co-creation. This SLR reveals that the living lab structure (and including sustainability labs and urban living labs) is the partnership structure utilized for innovation that addresses economic, social and environmental goals. Two areas are recommended for further research. One concerns the development of a deeper understanding of the relationship between the evolution in the structures of partnerships for innovation and how it is influenced by the globalization of the economy, society and environment, and changing modes of knowledge production. The other is to better understand why the living lab approach to partnership creation is best suited to the delivery of sustainable development objectives and how this learning can be applied to other models of partnership development at the university–industry–government nexus.

Keywords: triple helix; innovation; partnership development; sustainable development

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1. Introduction

Since the 1940s, there has been a push to encourage universities and industry to increase their engagement to commercialize research [1]. This started with the use of government procurement to encourage research and the development of innovative products [2] initially in the space, defense and energy sectors [3]. The 1950s and 1960s saw the development of science and/or technology parks to commercialize research [4] in America, which was followed, during the 1980s, in the UK [5].

During the 1980s, universities developed an increasing focus on technology transfer [6] to facilitate engagement with business. However, it was only from the 1990s that universities became directly involved in the world of business, actively seeking to commercialize their knowledge and research [3].

The benefits of collaboration range from the local (commercialization of research and innovation [7]) to the regional (revitalization of regions [8,9]) or national (catalyst for techno-economic development [10]) levels. Collaboration is a key part of modern innovation [11], which in turn is an important part of a well-developed entrepreneurial industrial sector [12].

The triple helix model [13] highlights the importance of a partnership between universities, industry and government to create innovation that meets business objectives in

developing and commercializing universities' research outcomes. Including government within the partnership creates outcomes that are socially and economically beneficial [14,15]. Others [16] have proposed the addition of a fourth helix (the quadruple helix) to promote a democratic approach to innovation, where society can provide feedback to create socially acceptable policies and practices. However, this model does not include the explicit consideration of non-market parameters, such as the natural environment [17]. The quintuple helix [18] seeks to address this shortcoming.

However, universities, industry and government struggle to effectively partner—particularly at scale—to deliver economic benefits from the commercialization of research outputs [19–21].

The aim of this systematic literature review (SLR) is to identify best practice partnership development to promote innovation at the university–industry–government nexus. To do this, it seeks to understand how universities partner with external organizations to deliver innovation and tracks the development of these partnerships.

This article is structured as follows. Section 2 sets out the methods used in the SLR; Section 3 provides a quantitative analysis of the papers revealed through the SLR; Section 4 discusses these results and puts forward a new understanding of the development of partnerships for innovation at the university–industry–government nexus; and Section 5 proposes a further research agenda.

2. Methods

The SLR offers a stringent methodology to interrogate a large body of data in a manner that is repeatable and evidence based [22]. This removes much of the inherent bias that can befall more traditional literature reviews [23]. However, using repeatable search terms does not in itself remove the potential for author bias [23]. The SLR provides a stringent approach, where the selection of studies is repeatable, but where the interpretation of those studies is left to the authors [24]. In order to develop a repeatable process for the interpretation of results, this study applies a thematic analysis approach developed by Massey (2011), which was initially proposed for use in interpreting the results of focus groups [25]. Massey's [25] process is applied here to further manage author bias by highlighting the epistemological foundation for the work.

This SLR is consistent with PRISMA (preferred reporting items for systematic reviews and meta-analysis) [26] and follows the process set out in Figure 1.

The articles were analyzed using Massey's model for thematic analysis [25]. This approach increases the replicability of the study, as it proposes three levels for data analysis: articulated, attributional and emergent [25]. Categorizing data into these three levels enables a transparent analysis which is repeatable and develops an analysis that is descriptive and based on a systematic approach.

However, Massey's (2011) model is not immediately transferable, as it was designed to be used for analyzing data arising from focus groups rather than from SLRs. Massey's three definitions of each data level are included in Table 1. The three levels of data should be viewed as a hierarchy, where the potential for bias is inverted according to its position in the hierarchy, with articulated data being subject to the least bias (and therefore, most replicable), whereas attributional and emergent data are the least transparent, due to the necessary engagement with the authors' views and experiences in the SLR process.

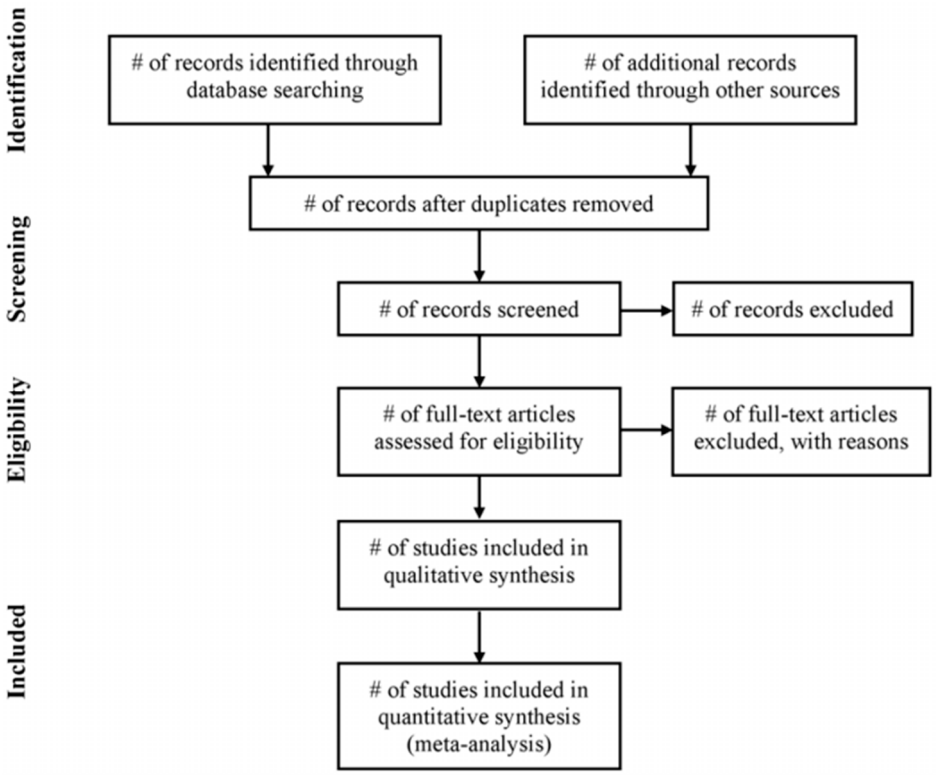

Figure 1. PRISMA—flow of information through the different phases of a systematic review [26]. The number of results is shown in Tables 2–8. # = number.

Table 1. Model for thematic analysis of data—based on [25].

Levels of Data	Original Definition	Revised Definition	Source of Data	Potential for Bias
Articulated data	Information that is expressed in response to, or specifically addresses the questions posed	Information that is stated directly by the original research authors as the result of their research. This is the original author's statement of results achieved and reported in the articled	Data are articulated by one or more study in the SLR	Lowest
Attributional data	Comments and discussion that relate to a priori hypotheses or theories that the evaluator brings to the study	Unchanged	Data are a co-location of ideas from 2 or more articles and are supported by extant models and theories	Medium
Emergent data	Information that contributes to new insights and hypothesis formulation and is the unanticipated product of individual comments and exchanges amongst group members.	Information that contributes to new insights and hypothesis formulation and is the unanticipated product of connections arising from different articles	Data that are the result of the consideration of articulated and attributional data. They are not necessarily supported by an extant body of work	Highest

2.1. Research Question

The aim of this SLR is to identify best practice partnership development to promote innovation in the university–industry–government nexus. To do this, it seeks to understand how universities partner with external organizations to deliver innovation. Further, it investigates the question of how innovation can be undertaken in a manner that is consistent with sustainable development.

2.2. Identification of Relevant Studies

Having defined the research question, it was then necessary to construct a search string for use in 3 key databases (ProQuest, Scopus and Web of Science). Defining the search terms was an iterative process, but the Boolean search was designed to reveal the state of the literature regarding how universities partner with business (and government) to transfer or develop knowledge to create and/or commercialize innovation.

The search was initially narrowed to include sustainability, carbon, sustainable development (and variants) in order to consider the appropriateness of the research or innovation to move society toward delivery of the sustainable development goals [27] but adding these elements to the search string returned too few articles from the search. A new search focusing on sustainable development and partnerships for innovation at the university–industry–government nexus was undertaken, which revealed a further 7 articles.

The development of the search string was determined from the problem definition and then combined into a Boolean research string (as set out in Table 2). Where the option was given, databases were searched for peer-reviewed articles written in English. There was no temporal constraint imposed.

Table 2. Development of Boolean search string.

Key Areas	String Expression
Activity	Innovati * or research
Location of activity	"campus develop *" OR "living lab *" OR "sus * lab *" OR "tech * park" OR "science park" OR "innovat * park"
Form of activity	collaboration OR "co-creat *" OR partner * OR "triple helix"
Between	university OR academi* OR college AND industry OR business OR commerce

* = root, stem or truncation.

2.3. Process of Filtering Studies in the Systematic Literature Review

The process of filtering studies in this SLR follows the PRISMA phases of a systematic review [26,28], with additional data considered relevant to the quantitative elements of the SLR retained.

2.3.1. Records Identified through Database Searching

The research string was run through all three databases in December 2020. The results for each database are shown in Table 3.

Table 3. Records identified through database searching.

Database	Boolean Search Results
Proquest	168
Scopus	151
Web of Science	171

2.3.2. Records Removed

Once the search of Scopus, Proquest and Web of Science was undertaken, the first step was to remove any duplicates within each database. Opinion articles and articles not in English were also removed from each database. The result of this process is shown in Table 4.

Table 4. Removal of duplicates, editorials and non-English papers.

Database	Search Results	Number Removed	Number Remaining
Proquest	168	14	154
Scopus	151	4	147
Web of Science	171	5	165

Having removed internal duplicates, editorials and non-English papers, all articles were reviewed to ensure that they were consistent with the objectives of the SLR. This process involved reviewing the titles and key words of the papers to make sure that the area of study was consistent with the research question. The results for this process are set out in Table 5.

Table 5. Removal of non-relevant papers (by title).

Database	Number of Papers	Number Removed	Number Remaining
Proquest	154	27	127
Scopus	147	2	145
Web of Science	165	35	130

Databases were amalgamated, and duplicates between databases were removed. The results can be seen in Table 6.

Table 6. Removal of duplicates between databases.

Database	Number of Papers	Number Removed	Number Remaining
Combined	402	65	337

2.3.3. Number of Records Screened (and Records Removed)

All abstracts were read to ensure that papers were relevant to the research question. Papers had to address innovation or research between two partners, either at some location or by addressing the issue of the location of the research or innovation activity. Papers that were not consistent with the research objectives of the SLR were removed. See Table 7.

Table 7. Removal of non-relevant papers (by abstract).

Database	Number of Papers	Number Removed	Number Remaining
Combined	337	154	183

2.3.4. Full Text Articles Assessed for Eligibility (Full Text Articles Excluded)

All papers that could be accessed were downloaded. Papers were then read and coded. Papers that were not consistent with the research criteria were at this stage eliminated. See Table 8.

Table 8. Final papers for data synthesis.

Database	Number of Papers	Number Removed	Number Remaining
Combined	183	51	132

2.3.5. Number of Studies Included in the Qualitative Synthesis and Meta-Analysis

The number of papers remaining in this study after the filtering was 132. These were then analyzed quantitatively (Section 3) and qualitatively (Section 4).

3. Results

The data were synthesized through two stages. Firstly, they were analyzed according to the factors detailed in Table 9. This part of the analysis dealt with issues such as publication date, type of study, location of where research/innovation took place, and location of the lead author.

Table 9. Data synthesis—data categorization (based on Eon and Morrison in print).

	Criteria	Description
1	Year of publication	Year that the article was published
2	Country of lead author affiliation	Location of lead author affiliation
3	Type of publication	Publications were differentiated into: Journal Book chapter Conference paper
4	Type of article	Articles were divided into three broad categories: Case studies (where performance of research and innovation at a specific location or locations were described and detailed). Review papers where performance of a series of partnerships were assessed and conclusions drawn about efficacy or partnership models, future policy or research direction. This includes literature reviews Model development identifying different means of assessing the performance of research and innovation partnerships.
5	Country where case study research took place	Location of where the case study took place
6	Physical location of where the innovation took place	Detailing the focus of the research on the physical space. Spaces (or places) were categorized: Nation state Regional (including rural and peripheral areas) City Science and Technology Park Campus Living lab

The second phase (see Section 4) was the synthesis of the data. Data were coded and synthesized into the three categories set out in Section 2.

3.1. Data Synthesis

All papers were categorized according to the criteria set out in Table 9. This categorization was undertaken to establish the year of publication, the location of the lead author, the type of publication and article, and the physical location of the innovation partnership. These data are largely factual, although there is an element of subjective interpretation in the categorization of papers.

3.1.1. Temporal Distribution of Studies

Of the 132 papers included in this study, 106 were published in the past 10 years. The trend in publishing is increasing and the interest in partnerships for innovation is similarly increasing (see Figure 2). This trend has been observed by others (for example [29,30]). A discussion for the drivers of the increased interests in partnerships for innovation, rather than the evidence of the increase in interest, is beyond the scope of this SLR. The

figures for 2020 represent data for 11 months (as the primary searches were conducted in December 2020).

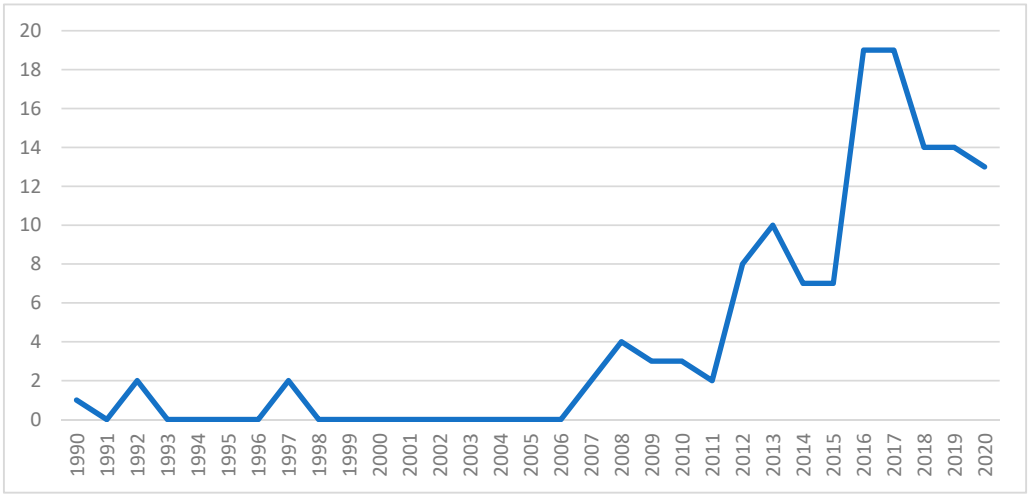

Figure 2. Temporal distribution of studies.

3.1.2. Country of Lead Author Affiliation

The country of the lead author affiliation is set out in Figure 3. The top 5 European countries published 69 studies or 52% of all the studies in the SLR. European authors published 78% of the papers identified in this SLR.

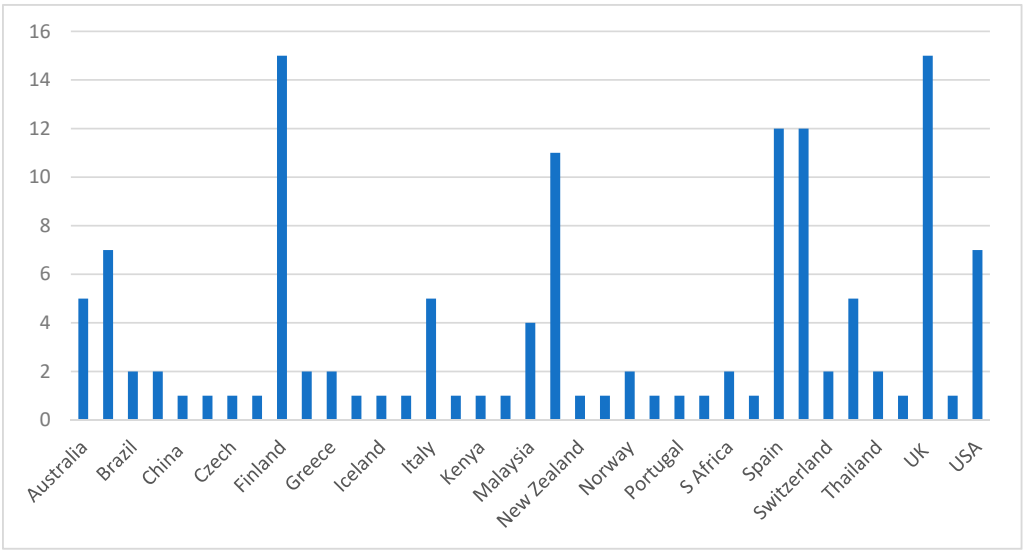

Figure 3. Lead author—country of affiliation.

A breakdown of lead author affiliation by continent is given in Table 10. This reinforces the dominance of Europe for research into partnerships for innovation. The dominance of Europe in the research field is not surprising, given that the co-creation of innovation was a priority of the Finnish Presidency of the European Council in 2006 [31].

Table 10. Lead author—affiliation by continent.

Continent	Number of Papers
Europe	97
Asia	13
N. America	9
Australia/Oceania	6
Africa	5
S. America	2

3.1.3. Type of Publication

Table 11 illustrates the breakdown of the sources for the articles used in this SLR: 85% were journal articles, with 4% being from conference papers.

Table 11. Type of publication.

Type of Publication	Number of Papers
Journal article	112
Book chapter	14
Conference paper	6

3.1.4. Type of Article

This SLR considered 132 articles. The type of article is set out in Table 12. For this analysis, we used only three broad categories of articles, as drawing the boundaries is difficult and ultimately adds little to the sum of knowledge. The principle of Occam's razor was applied [30].

Table 12. Type of article.

Type of Article	Number of Papers
Case study	103
Review	24
Model development	5

A case study was deemed to be a study looking at a specific partnership that was used for research and/or innovation (these could be site specific, region specific, sector specific, or process specific). A review was defined as a study that considered the performance of a range of case studies to develop a future research agenda, present that state of the field, or make proposals for future policy. Finally, model development was defined as the development of evidence for proposals of new performance matrices or new forms of partnerships. Undertaking even such a simplified classification process requires the application of expertise and is, therefore, subjective.

3.1.5. Case Study—Location and Focus

An analysis was undertaken of the physical and geographic location of the 104 case studies in this SLR. The physical location was defined as the place, or predominant place, where the partnership for innovation took place. Table 13 demonstrates the physical (rather than geographic) location of all 103 case studies reviewed by this SLR.

Table 13. Focus area of case studies.

Focus Area of Case Study	Number of Papers
Science and Technology Park	28
Campus	21
Living Lab	21
City	14
Regions	11
National	6
Business	2

3.1.6. Single Country Case Studies

There were 87 single case studies in this SLR, with the remaining being trans-border or trans-continent. This demonstrates the importance of Europe to research into partnerships for innovation. Figure 4 details the geographic location of the single case studies.

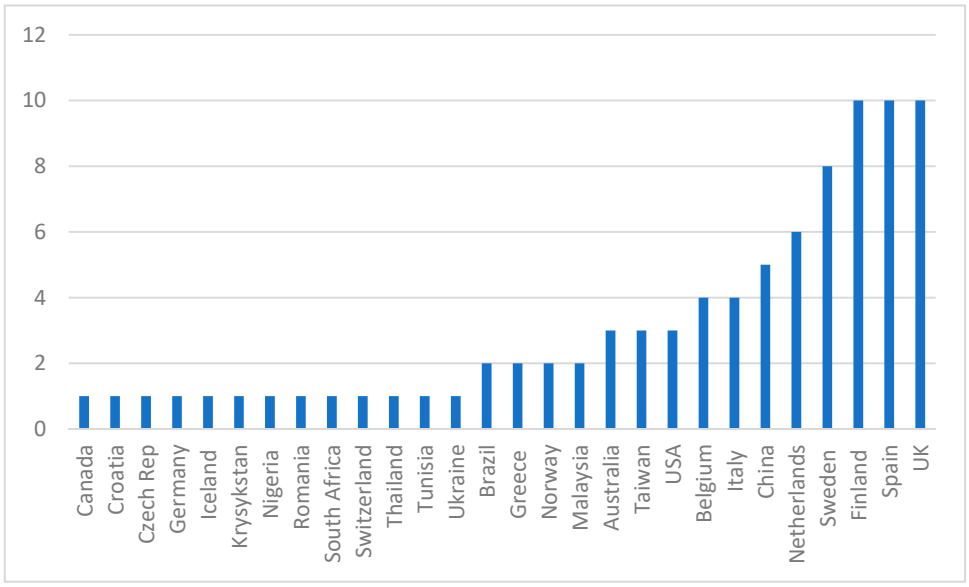

Figure 4. Country of single case study.

3.1.7. Case Studies in More Than One Country

There were 18 studies that were trans-border case studies; details are set out in Table 14.

Table 14. Trans-border case studies.

Trans-Border	Countries	Number of Case Studies	Authors
International	The Netherlands, USA.	1	Curvelo Magdaniel, De Jonge [32]
	Spain, S. Africa, Hungary, Czech Republic, Finland	1	Schaffers, Cordoba [33]
	USA., Greece, Portugal	1	Schoonmaker and Carayannis [34]
	Finland, South Africa, Spain, Sweden	3	Leminen, Westerlund [35] Leminen [36] Leminen, Nyström [37]
	Spain, Hungary, South Africa	1	Guzman, Schaffers [15]

Table 14. *Cont.*

Trans-Border	Countries	Number of Case Studies	Authors
International	Spain, Mexico	1	Olvera, Piqué [4]
	USA, Iran	1	Aslani, Eftekhari [38]
	USA, UK, Bulgaria	1	Purcell, Henriksen [39]
Intra-European	Sweden, Finland	1	Buhr, Federley [40]
	Denmark, Norway	1	Nielsen [41]
	Finland, Belgium	1	Veeckman, Schuurman [42]
	Portugal, UK	2	Martins [43] Germain-Alamartine and Moghadam-Saman [44]
	The Netherlands, Sweden, Finland	1	Voytenko, McCormick [45]
	Finland, Spain	1	Almirall, Lee [46]
Asia	South Korea, Taiwan	1	Yun and Lee [47]

4. Discussion and Analysis of the Data

The data in this SLR were analyzed using a systematic process and the results are discussed below. Section 4.1 sets out the articulated data—these are data that are revealed by one or more study. The evolution of a non-hierarchical structure emerged to assist with understanding the development of partnerships for innovation at the university–industry–government nexus. Section 4.2 presents the epistemological backdrop to the articles to present a more nuanced understanding of the articulated data. Section 4.3 presents emergent data, which are author insights developed through engagement with the articulated and attributional data.

4.1. Articulated Data

This section presents the thematic results of the data analysis as revealed by the SLR. The aim of this SLR is to reveal best practice partnership development to promote innovation in the university–industry–government nexus. To do this, it seeks to understand how and why universities partner with external organizations to deliver innovation.

This section is divided as follows. Firstly, there is a reprise of the theory of partnership development at the university–industry–government nexus (Section 4.1.1). Following this is a discussion of the intermediaries for innovation created at the university–industry–government nexus and how they are currently portrayed in the literature (Section 4.1.2). Finally, an evolutionary view of the creation of intermediaries for innovation is proposed (Section 4.1.3) that describes the development of partnerships for innovation. These are based not solely on dynamics within the partnerships, but on external factors that have facilitated, or enabled, new forms of intermediaries for innovation (Section 4.1.3 present the evolution of the three forms of partnership revealed in this SLR at the university–industry–government nexus).

4.1.1. Innovation at the University–Industry–Government Nexus

Economies have become increasingly dependent on the exploitation of knowledge for continued economic growth [1,4] and the role of the university is widely debated [48–51]. Universities play a key role in furthering future economic development, due to their missions to educate, carry out research and engage [52,53]. It is the third mission (engagement) that gets the most attention in terms of how universities can most effectively use the knowledge they create to further economic development [54,55] and do so in a manner that is in the economic interest of society [56,57]. To efficiently utilize their expertise in knowledge creation for the economic benefit of society, there is a need to interact, or partner,

with other organizations [34]. There is limited discussion about how universities themselves might use innovation to improve their offerings under missions one and two (see, for example [58,59]).

There is an ongoing conversation about the triple helix, where universities, government and industry interact to help drive knowledge-based economic development, particularly in an industrialized economy [51,60]. Academic interest in partnerships for innovation is increasing as reflected in Section 3.1.1. The triple helix model is largely accepted as a useful starting point to understand the changing roles of universities, industry and government to partner in innovation to drive economic development.

4.1.2. Intermediaries for Innovation at the University–Industry–Government Nexus

The SLR reveals that the innovation intermediaries created by university, industry and government are created through an internal dynamic, and these are either management led (top-down) or led by an entrepreneurial individual or group (bottom-up) [54,60]. These types of intermediaries for innovation, as identified in the literature, are shown in Figure 5.

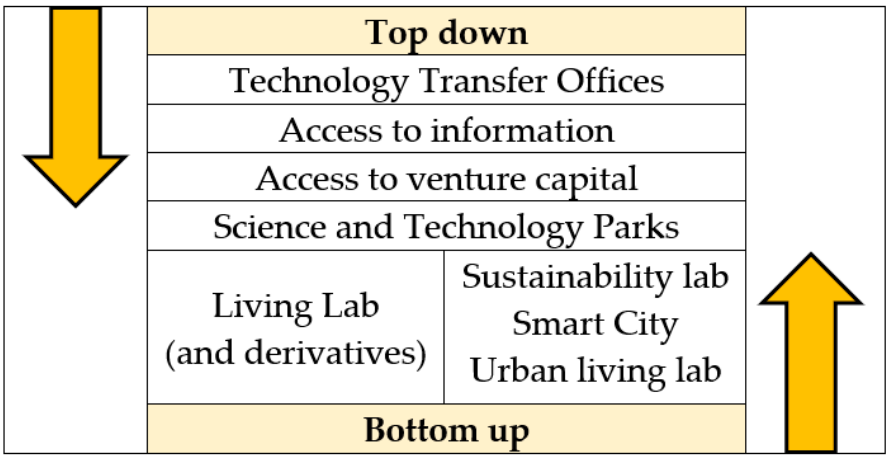

Figure 5. Innovation intermediaries in our society [54,60].

Whilst there is a focus on economic development, it is clear from the literature that the deepening knowledge-based economy is affecting not only how industry, government and universities interact, but also how consumers and citizens [34] interact with other partners in the innovation ecosystem. The pace of change affects all sectors of society (university, industry, government as well as people), and this dynamic relationship is rapidly changing, which is leading to new forms of intermediaries that are highly individualized [61]. This, in turn, leads to the opportunity for innovation at different scales and under differing dynamics and delivering different outcomes [62,63].

Various forms of intermediaries are being created as a result of internal dynamics, but also being facilitated by external opportunities and stimuli (exogenous factors). It is this overlay of changing dynamics that has led to new forms of intermediaries for emerging innovation [64] and that are being led by, or include, different actors [65] or different power dynamics and approaches [62,66]. Additionally, new models for innovation are being adopted by different sectors—including the public sector [67] or cities [68]. It is this change in dynamics, structure and power relationships that is leading to the nascent creation of innovation that is seeking to deliver economic, social and environmental enhancements at the same time [19].

4.1.3. Evolution of Intermediaries for Innovation

This SLR reveals an evolution in the ecosystem of intermediaries for innovation. Intermediaries for innovation are individuals or organizations whose role it is to span the boundaries between organizations to facilitate innovation [69]. Innovation intermediaries

are evolving from a simple partnership model of a technology transfer officer, through to the development of science and technology parks (STPs) and through to living labs and smart cities. This is a non-linear pathway [60], partly due to the rapid change in the nature of the knowledge-based economy—where knowledge is increasingly shared rather than owned [67], partly as a reflection of a change in knowledge production [16] and partly due to an increased focus (particularly in industrial economies) on the importance of the service-based economy, where service (experiential or simply more tailored [46]) is seen as another key to unlock economic development.

- On Campus Structures

On-campus structures includes the creation of several organizational structures within universities to promote the development of partnerships for innovation. These forms of partnership are the simplest and are an organizational response to facilitate the creation of an increasingly entrepreneurial university [60]. In the initial phases at least, this is conducted on campus.

The structures put in place range from technology transfer offices [69], academic liaison officers [56] to act as an intermediary between the university and business, processes to facilitate access to library information for business [52] and the creation of incubators to help start-ups grow into functioning businesses [70]. The purpose of these mechanisms is to assist the transfer of knowledge from the researcher to the consumer via a business.

There is also some evidence in this SLR of the campus itself being used as an innovation, and these were underpinned by a planning perspective [71], asset management [72], by opening up the campus [73] or using the campus to drive radical innovation through institutionalization [74]. These studies show the potential for the entrepreneurial university to drive all three modes (education, research and commercialization) through the operation or development of the campus.

- Development of Campus-Adjacent Structures

The second significant phase in the development of intermediaries for innovation is the creation of campus-adjacent structures to further the partnership between universities and business. In this SLR, there were 28 case studies looking at STPs (see Section 3.1.5). The impetus for the creation of these off-site structures seems to be university, or government driven, but there are examples of it being driven by the private real estate sector [32]. In this SLR, most papers considering STPs focused on a traditional form of STP, where a university creates spaces for businesses to occupy to deliver innovative goods and services (ideally based on or related to the intellectual output of the university).

These campus-adjacent structures have a complex nomenclature, but in this SLR, they are referred to as science and technology parks (STP). This is a generic term to take in research parks, technology parks, innovation parks and business parks. The key definition issue is that they are developed to create an environment conducive to the co-creation of economic value by business, ideally using university created knowledge. They are geographically proximate to the university and tend to focus on the research strengths of the university.

The value of geographical proximity is much debated [75]. This SLR showed strong informal connections between universities and business [52,76–78] based on geography but with less evidence of formal connections that deliver innovation based on university-created knowledge [75,79]. One study found that 92% of the on-park research and technology output was through private industry [80], with others considering the role of private capital to innovation success [50], the role of university finance to spin-off success [81] or the role of management [82], or the network benefit [83]. This does not, in itself, mean that STPs represent a failed policy, but that there is not strong evidence for the successful transference of knowledge from creator to consumer via a business based in the university's STP. The depth of these relationships depends upon the level of service offered by the university to its tenants—with non-core assistance (for example, human resource management functions) being valued by tenants [77] or the value of social capital to start-up success [49].

There is also a stream of work researching the connection between the university and the STP covering the role of knowledge transfer facilitated by librarians [56], the influence of the university on the STP [84], the impact of doctoral education [44] or a more holistic consideration of the STP compared to a technology transfer officer or other intermediaries (see Section 4.1.3) [69].

Although the usefulness of STPs is still subject to debate, the creation of STPs has been adopted in Europe [7,9,41,70,79,80,85–88] and North America [1], and STPs are widely emulated in the former Eastern bloc countries [11,89,90], as well as the centralized economies of China [2,55,91], Taiwan [92,93], Malaysia [53] and others in Asia; the creation of STPs is also seen as a pathway for economic development in developing nations [8,94–96] as well as being subject to international comparisons [4,34,38,47].

- Development of Living Labs

The next phase in the evolution of intermediaries for innovation is the creation of living labs. As shown in Section 3.1.5, there is a significant body of work which investigates the role of living labs. These are partnership structures that are focused on user engagement and open innovation. The partners are varied but generally involve university, business, and government (at some level). Living labs (and derivatives) are driven by a desire to innovate within the partnership and this might be the deepening of research findings [97], creating a product or service to commercialize the research [98] or co-creating a new product or service [99].

The external change that is facilitating the development of living labs is the ability for a range of stakeholders to become freely involved in the process of innovation [100]. The service-dominant logic [48], open innovation [101], user innovation [29], user-centered design [102] or even social (rather than economic) innovation [103] have become possible due to the ability to create communities of interest for almost anyone.

Living labs (and derivatives) are widely debated in the literature and are normally considered a network that incorporates both user engagement and open innovation [35]; they have the characteristics as set out in Table 15. There are several forms of living labs, which are also evolving. Sustainability labs [104] are focused on the delivery of economic, social and environmental outcomes at a geographic location. Smart cities are developed as a higher systems level solution under which living labs enable the demonstration and prototyping of products and services. Urban living labs are a network structure within an urban environment [64].

Table 15. Living lab characteristics [29].

Characteristic	Explanation
Real life environments	Real life experimentation to test, develop, research new products, services, systems, processes
Stakeholders	Range of partner involvement to co-create. Stakeholders are key to the outputs of the living lab
Activities	What the living lab will focus upon. This is defined by whoever is driving the innovation (and is key to delivery of the output/outcome)
Business models	Covers how the living lab will operate (essentially why it exists and how it will continue to exist)
Methods and tools	The approach taken to innovation
Challenges	Economic, social and/or environmental
Output and/or outcomes	What the living lab delivers
Sustainability	Emergence of innovation that moves society toward delivery of the sustainable development goals

However, both the literature and practitioners struggle to define living labs and their derivatives [29,64], or to create business cases to build them [65,104], or even best practice guides to help manage them [31]. They are a rapidly evolving creation that, in many respects, is a direct expression of the partnership that created them [104]. That said, there are structures to suit different desired outcomes, such as wicked issues [105] or radical innovation [74], and they are grouped into a genus containing 4 typologies characterized by open innovation: utilizer driven, enabler driven, provider driven, and user driven [35].

At the heart of living labs are two key elements: user engagement and open innovation [35]. These two aspects are evident in the case studies in this SLR. It is these two aspects that stand them apart as intermediaries for innovation. Because of this commitment—facilitated by the knowledge economy and technological developments—living labs are footloose. They can be on campus [59,71,73,106–109], off campus [9], in an STP [48], on a high street [110], local [65,90,97,111,112], precinct scale [113], urban [100,114–118], suburban [40,66], rural [15], regional [101,105], peripheral [119] or city scale [68,99,102,116,120–123]. They can also be virtual [124].

It is partly this footloose, open and creative element that means that they are potentially difficult to harness at scale: indeed, difficult to harness by policy makers, but also difficult to harness by businesses, universities and the public. These structures are innovative in themselves; each is unique (even with common elements) and each is designed to serve a purpose. Their amorphous shape and shifting nature make them difficult to grasp and initiate at scale. Whilst STPs could be created by policy diktat [76], living labs cannot and as such are more ephemeral and can be a conundrum to universities, business and government. This transformational change of the modus operandii means that a once linear, or apparently linear evolution [60], is now beset by new branches and new forms (such as sustainability labs, urban living labs, and smart cities). These branches and forms are being created at such a pace that the literature is struggling to define them [64], or adequately develop theories to help amortize their existence [125].

- Living Labs and Sustainable Development

In this SLR, living labs (and derivatives) are the partnership structure that is being used successfully to drive social and economic development [62,126]. It is also the structure that is used in the limited number of studies that are using innovation to drive the delivery of sustainable development [19,29,40,73,96,107,109,115,127–132], with the emphasis on both sustainability labs and urban living labs. The literature does not provide guidance for the reasons for this. In a time when the Sustainable Development Goals have been unanimously agreed by the United Nations, it is noteworthy that the literature around developing partnerships for innovation is largely silent on the implications for innovation (an issue also noted by others [29]).

4.2. Attributional Data

As discussed in Section 2, outlined in Table 16, and as defined by Massey (2011), but amended here to meet the needs of an SLR, attributional data relate to comments and discussion about a priori hypotheses or theories that the evaluator brings to the discussion. The data collected are the result of author expertise and assessment, as, in most cases, the theory that underpinned each study went unstated in the study.

Table 16. Categorization and paper breakdown of theories underpinning SLR.

Theme	Theory	Sub-Theory
Economic development [1,8,10,57,76] Economic geography [75,96]	Innovation theory [7,11,15,46,49,53,54,60,62,63,70,78,90,94,110,123,133–136]	Open innovation theory [3,35–37,58,62,64,67,69,97,101,113,118,125,137–140]
		Innovation management theory [100,114,132]
		User innovation theory [141,142]
		Collaborative knowledge production [108,118]
		Service or product dominant [48,66,72,74]
		Frugal innovation [133]
	Growth theory [38,82,102]	Knowledge transfer theory [52]
		Knowledge spill-over theory of entrepreneurship [81]
		Development economics [143]
	Regional development [54,68,83,92,93,106,109,119,120,144]	Agglomeration economics [55,145]
	Management theory [4,42,50,79]	Business design concepts [33]
		Business excellence/total quality management [31]
		Construction management [146]
		Corporate real estate management theory [32]
		New public management theory [41]
	Socio-institutional economics [119]	
	New institutionalism [89]	
	Neo-institutional economics [116]	
Systems Theory [11,91,150,151]	Network theories [34,35,47,112,147,148]	Business network theory [102]
		Actor network theory [149]
	Self-organizing systems [71]	
	Socio technical Systems [73,107]	
	Process-based engineering [38]	

Table 16. *Cont.*

Theme	Theory	Sub-Theory
Planning [124,125]	Transition theory [39,88,92,117]	Urban sustainability transition [99,121]
		Transitions theory (sustainability) [45,96,108,117,129,131]
		Transition management [107]
		Value of sustainable development [40,129,131]
	Design theory [104]	Academic capitalism [71,150]
Social theories	Social practice theory [61,104,109]	
	Social capital theory [40,49]	
	Social network analysis [9,80,84–87]	
	Social entrepreneurship [103]	
	Social institutionalism [51]	
Theories of learning	Interorganizational learning [44,52]	
	Experiential learning [56,127]	
	Informed learning [124]	
	Social learning [98]	
	Audit-based learning [59]	
	Absorptive capacity [43,77]	

The selected papers in this SLR were underpinned by 28 different theories (as detailed in Table 16). The theories supporting the research reveal three intersecting themes which were categorized as economic development, social theories and a thinner vein on theories of learning.

Most studies have an economic theoretical underpinning (see Table 16 for a detailed disposition of the papers and their theoretical underpinning) developed through theories of innovation, economic geography, planning and transitions.

Aligned with economic development is a suite of papers dealing with social theories. This encapsulates both how society develops, but also how individuals interact with partnerships. To some degree, this is the practical element in the development of the papers, as it focuses the papers on the theory of how individuals in society interact with innovation.

The final theoretical category is around theories of learning. This is a shallower vein of research that links through to economic development and social theories but can be divided into two theoretical strands. One is how, particularly, (though not exclusively) universities can use innovation to help deliver learning to their students. The other strand relates to continuous improvement and considers how organizations (individually and collectively) can retain and improve upon their learning by doing.

4.3. Emergent Data

This section of the SLR deals with emergent data. For the purposes of this SLR, emergent data were defined as information that contributes to new insights and hypothesis formulation and are the unanticipated product of connections arising from different articles. They are therefore the result of the consideration of the articulated and attributional data. They are not necessarily supported by an extant body of work, but they do highlight the areas where further research, particularly in the development of theoretical underpinnings is recommended. There are two emerging themes from this SLR that warrant further consideration.

The first relates to the evolution of partnerships for innovation and the potential relationship with globalization of the economy, society and environment. In the literature reviewed for this SLR, the development of partnerships for innovation is depicted as a process largely driven by decisions within the partnership. This SLR has proposed an evolution in the development of partnerships for innovation. However, emerging from this SLR is a nascent, but to date unresearched, relationship between the evolution of partnerships for innovation, the increasing globalization of the economy, society and environment and the development of modes of knowledge production.

The evolution of partnerships for innovation was discussed in Section 4.1.1. The increased globalization of the knowledge economy is a driver of the development of partnerships at the university–industry–government nexus. However, the globalization of society, through widespread adoption of the internet, also appears to be influencing the development of partnerships for innovation (as reflected through work on the quadruple helix [151] as well as wider moves toward open science [152]).

There is also some evidence of the impact of the globalization of the environment in the development of intermediaries for innovation. This SLR revealed a thin vein of work (as did [29]) looking at the use of partnerships for innovation to deliver sustainable development. The link between sustainable development and one form of partnerships for innovation exists, but there is currently little in the literature to provide an understanding of why living labs are the preferred partnership structure to deliver sustainable innovation.

As the same time, there is some discussion of the evolution of modes of knowledge production. Mode 1 is discipline based and produces theoretical knowledge; Mode 2 is transdisciplinary and is characterized by being applied research [14]; Mode 3 is a transdisciplinary ecosystem to enable people, culture and technology to interact across scientific and technological disciplines [151].

In this SLR, no paper explicitly addressed the relationship between the changing external landscape and the evolution of partnerships for innovation, but it would appear there is some form of relationship, and this emerging hypothesis is presented in Table 17. The hypothesis is based on the delivery of the three elements of sustainable development (economic growth, social development and environmental quality) at the same time rather than in isolation from each other. It is this balancing and integration of economic, social and environmental factors that seems to distinguish the living lab approach as the preferred partnership structure used to deliver sustainable development from the other forms of partnership (as discussed in Section 4.1.3).

Table 17. Hypothesis of current relationship between partnerships, globalization and modes of knowledge production.

Evolution of Partnerships for Innovation	Potential Partnership Response to Trends in Globalization			Changes in Knowledge Production
On campus	Economy			Modes 1 and 2
Campus adjacent		Society		Modes 2 and 3
Living labs			Environment	Mode 3

The second theme relates to the discussion in the papers of the triple helix [60], which are driven from a primarily economic perspective (see Section 4.2). The inclusion of a quadruple helix to include the public or citizens did take the model into a more clearly defined social territory, but the debate focused on driving the public perspective in innovation.

The papers reviewed illustrate that only living labs deal with sustainable development. The question remains unanswered as to how society can be confident that the framework driving innovation protects the interests of the global citizen. The interest of the global citizen is encompassed at the strategic level by the sustainable development goals. The relatively light body of research, revealed in [29] and in this SLR, on how to utilize partnerships for innovation to deliver the SDGs reveals a gap in the research literature.

5. Conclusions and Further Research

This SLR has described an evolutionary approach to understanding the development of partnerships at the university–industry–government nexus. The evolution of the partnership structures begins with structures on campus; it then evolves into structures adjacent to campuses and finally to the development of living labs (and derivatives), which are footloose and found in a variety of locations. One reason for the evolution of living labs is the ability to create communities of interest for almost anyone. This evolutionary approach builds on the top-down/bottom-up approach currently described in the literature (see Figure 5). This insight into the evolution of partnerships for innovation is important from a theoretical and practical perspective.

From a theoretical perspective, the evolution in partnerships for innovation opens up the question of, what is driving the evolution. As discussed in Section 4.3, the partnerships for innovation are evolving at the same time as there is globalization of the economy, society and environment and a progressive change in the modes of knowledge production. This insight is helpful in understanding the evolution of partnerships for innovation at the university–industry–government nexus by developing an understanding of how factors external to the partnership may be affecting the evolution of the partnership structures. This finding demonstrates that partnerships for innovation sit within a wider innovation ecosystem that is also evolving.

The SLR also revealed that the partnership structures are evolving at a pace where the literature struggles to define them or develop theories as to their existence. There would be value in understanding the relationship, if any, between these processes to help further understand the factors that are driving the changes in partnerships for innovation.

Practitioners will also benefit from the new understanding of the evolution of partnerships for innovation into increasingly complex structures. Practitioners will be better able to understand how partnerships for innovation are changing, which may provide clearer insights into the most appropriate structure for what they are seeking to achieve which will, in turn, assist them in learning from experience rather than solely by doing.

This SLR also revealed that the predominant focus of the partnerships is economic development underpinned through theories of innovation, economic geography, planning and transitions. There is a stream of research that is focused on economic and social development, and a more limited number of research papers deal with sustainable development (this finding is also reflected elsewhere, for example, in [29]).

In this SLR, the only partnership structure that sought to further sustainable development was the living lab approach (and specifically sustainability labs and urban living labs). This SLR did not reveal the reasons why this is the case, and further research needs to be undertaken to understand why living labs might be considered the preferred structure to promote economic, social and environmental innovation. Further research is also needed to understand the barriers that are standing in the way of the other structures (on campus and campus adjacent) being used to further sustainable development objectives. The literature reviewed in this SLR is silent on the implications of the unanimously adopted Sustainable Development Goals on the development of partnerships for innovation at the university–industry–government nexus, and this gap in the research needs to be filled.

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