Journal of the Knowledge Economy
https://doi.org/10.1007/s13132-025-02676-y

What Makes University-Enterprise Collaborations Successful? An Integrative Review

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Received: 26 August 2024 / Accepted: 26 February 2025

Abstract

This review was conducted as part of a broader research project, "Strengthening University-Enterprise Collaboration for Resilient Communities in Asia." The aim of the project was to map the collaborative architecture of partner universities with the public and private sectors to enhance social and economic development. An integrative method was adopted to systematically identify eligible literature and synthesise relevant findings regarding processes, dynamics, and factors involved in the formation, maintenance, and governance of successful university enterprise collaboration (UEC). Ninety articles met the inclusion criteria and encompassed several processes, dynamics, and factors related to the development, maintenance, and governance of successful UECs including, definitions, frameworks, types, formation, timelines, barriers, and enablers. Measurements of UEC success and good practices were also identified. The findings enhance the understanding of what makes a successful UEC. This review is the first phase in the development of a heuristic UEC framework that facilitates collaborative success for social and economic development. The review utilises a novel approach to synthesise a vast body of UEC literature encompassing a diverse range of processes, dynamics, and factors that contribute to the development, maintenance, and governance of successful UECs.

Keywords University-enterprise collaboration · University-industry collaboration · Knowledge transfer · Public-private partnerships · Formation · Maintenance · Governance · Success factors

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Published online: 10 March 2025

Introduction

Arguably, privatisation was pioneered in the UK in the 1980s and early 1990s, when a conservative government launched extensive programmes involving the transfer of assets such as gas, electricity, and water from the public to the private sector (Ramanadham, 2019). This shift marked the beginning of widespread public–private partnerships (PPPs) which are cooperative arrangements between public and private sectors (Bovis, 2012; Hodge & Greve, 2007). PPPs were intended to facilitate efficient, economical, and quantifiable public services whilst minimising financial risk (Bovis, 2012; Kwak et al., 2009). Initially focused on traditional infrastructure and services, PPP evolved and began influencing education, particularly as universities sought additional funding sources in response to reductions in public support (McCann et al., 2019; Williams, 1997). Within this context, university-enterprise collaborations (UECs) emerged as a contemporary form of PPP, with universities leveraging private sector partnerships to support research, innovation, and practical applications of academic knowledge (Damoc, 2017).

The trend toward privatisation has encouraged universities to engage more actively with private sector stakeholders, driving partnerships that support applied research and foster innovation (Balan, 2023). UECs can be seen as part of a broader resource-sharing model where universities increasingly depend on external funding and collaborative arrangements to fulfil their mandates in knowledge generation and societal contribution (Berbegal-Mirabent et al., 2015; Lakpetch & Lorsuwannarat, 2012). This evolution aligns with resource dependency theory, which suggests that organisations form partnerships to secure essential resources (Biermann & Harsch, 2017). At the same time, the concept of UECs also aligns with knowledge transfer theory, which underscores the importance of partnerships for practical applications of academic knowledge (Watson & Hewett, 2006). As part of the UK's innovation policy, UECs are therefore seen as critical pathways through which universities can align academic outputs with the needs of industry and society and thus contribute directly to economic and social progress (Department for Science, Innovation & Technology, 2023).

Over the last thirty years, there has been a drive towards UEC, which benefits businesses, universities, and the wider community (Liang et al., 2012; Williams, 1997). Collaborative work between university researchers and external stakeholders reduces the barriers created by disciplinary, cultural, and organisational borders and is essential for tackling complex challenges within science and society (Hall et al., 2018). As such, UEC is a vital enabler of economic and innovative prosperity, as collaborative interactions provide new opportunities and knowledge for economic growth and social progression (Pinheiro et al., 2015).

Due to the benefits of UECs, policymakers have sought to support the sharing of academic knowledge beyond the traditional routes associated with university research and teaching (Rybnicek & Königsgruber, 2019). However, some collaborations yield significant successes, whilst others do not. Therefore, it is vital to understand the factors and dynamics that facilitate successful UECs to develop effective frameworks for collaborative projects between universities and private sectors.

Purpose of Review

This integrative review was conducted as part of a broader research project funded by ERASMUS+, "Strengthening University-Enterprise Collaboration for Resilient Communities in Asia (SECRA)." The aim of the project was to map the collaborative architecture of partner universities with the public and private sectors to enhance social and economic development. The review aimed to *s*ynthesise relevant findings regarding the processes, dynamics, and factors involved in the formation, maintenance, and governance of successful university enterprise collaboration (UEC) by addressing three research questions: how are UECs formed? How are UECs maintained? How are UECs governed?

Methodology

In contrast to systematic reviews, which typically intend to summarise all primary research in response to a research question (Clarke, 2011), an integrative approach (Torraco, 2005) was adopted to effectively identify and assess eligible literature to address the research questions. The decision to include a wide range of literature comprised of various methodologies was taken to compensate for the lack of an explicit methodology or standardised metrics for UEC and ensure that relevant articles were included in the review. Every attempt was made to ensure the review was conducted as systematically as possible regarding the identification, selection, and synthesis of published literature.

The first step in conducting this integrative review was the development of a search strategy (Torraco, 2005). The search aimed to capture an unbiased and comprehensive list of published literature. The search terms were generated from scoping searches and were intentionally broad to identify all potentially relevant studies. As Google Scholar limits search strategies to a maximum of 256 characters, including spaces, the search strategy was kept below this threshold for all databases to maintain the consistency of search terms used within each database (Bramer et al., 2017). Articles were sourced from three databases, including Web of Science, Google Scholar, and Embase, with the last search conducted on 16/06/2021. The topic (title, keywords, abstract and full-text) of articles in online databases was searched using the search strings in Table 1. Where appropriate, search terms within each group were combined using the Boolean OR operator and between groups using the Boolean AND operator.

Exclusion criteria were devised to eliminate non-relevant articles. The search was limited to articles written in English. Articles were not restricted by year, yet no eligible articles were published before 2000; those published most recently were prioritised to ensure the most up-to-date information was included. No restrictions were applied regarding the country of publication because literature from European and non-European countries was anticipated to be directly relevant to the overarching aims of the review. Due to resource and time constraints, only published literature where the full-text was available was included.

Table 1 Search terms for online database searches

Search string part 1	Search string part 2	Search string part 3	Search string part 4	Search string part 5
'University enterprise' or 'University partnership'	Framework or model or theory or approach	Formation or collaboration or establishment or maintenance or timeline	Barriers or limitations or enabl* or enhance* or promote* or driv* 'good practice' or 'best practice'	Polic* or guide* or report or review or law or legislation

Note: *A wildcard

In the next step of the integrative review, a stepwise approach was adopted to assess the eligibility of articles included in the review. First, titles and abstracts were screened; irrelevant or duplicate articles and those not written in English were excluded. Next, a reviewer screened all the remaining full-text articles to assess their eligibility. Reference lists from eligible articles were also searched to identify relevant references. Literature regarding UEC varies in terms of methodology, findings and scope. There is a lack of established methods for assessing the methodological quality and relevance of articles in UEC (Fernandes et al., 2019). Therefore, to ensure the inclusion of high-quality articles, the literature was further restricted to the first 200 highest papers, as citations can indicate research quality (Leydesdorff & Ivanova, 2016) and relevance (Aksnes et al., 2019).

A data pro-forma was then used to systematically collect key information from each study. This process began by documenting basic study characteristics, including author(s), publication year. Key information was also extracted from eligible articles to directly address the research questions. This information encompassed concepts relating to UEC definitions, frameworks, types of UECs, and how they are formed, timelines of UEC, measurements of UEC success, considerations during the formation of UECs, UEC policies and good practices.

Once data extraction was complete, a concept-centric approach was then used to synthesise concepts that emerged within eligible articles, thus allowing a complete literature consensus to be accrued (Webster & Watson, 2002). A concept-centric approach to data synthesis provided a relatively simple method for assessing the point of 'data saturation', i.e., the point at which no new concepts emerged (Webster & Watson, 2002). Concepts were organised into matrices that permitted the synthesis of common concepts between articles. Concepts were then confirmed and interpreted via an iterative process, whereby a further two reviewers checked the decisions of the first reviewer. The findings regarding each concept were used to make general observations, draw conclusions, and make recommendations, including implications for research and practice.

Results

Article Selection

The search of relevant databases yielded 513,844 articles. However, once limits were applied, 497,927 articles remained. Restricting literature to the first 200 highest cited papers in each database left 600 articles eligible for full-text screening. Application of inclusion criteria meant that 89 full-text articles were eligible for inclusion. A summary of the article selection process is demonstrated in Fig. 1.

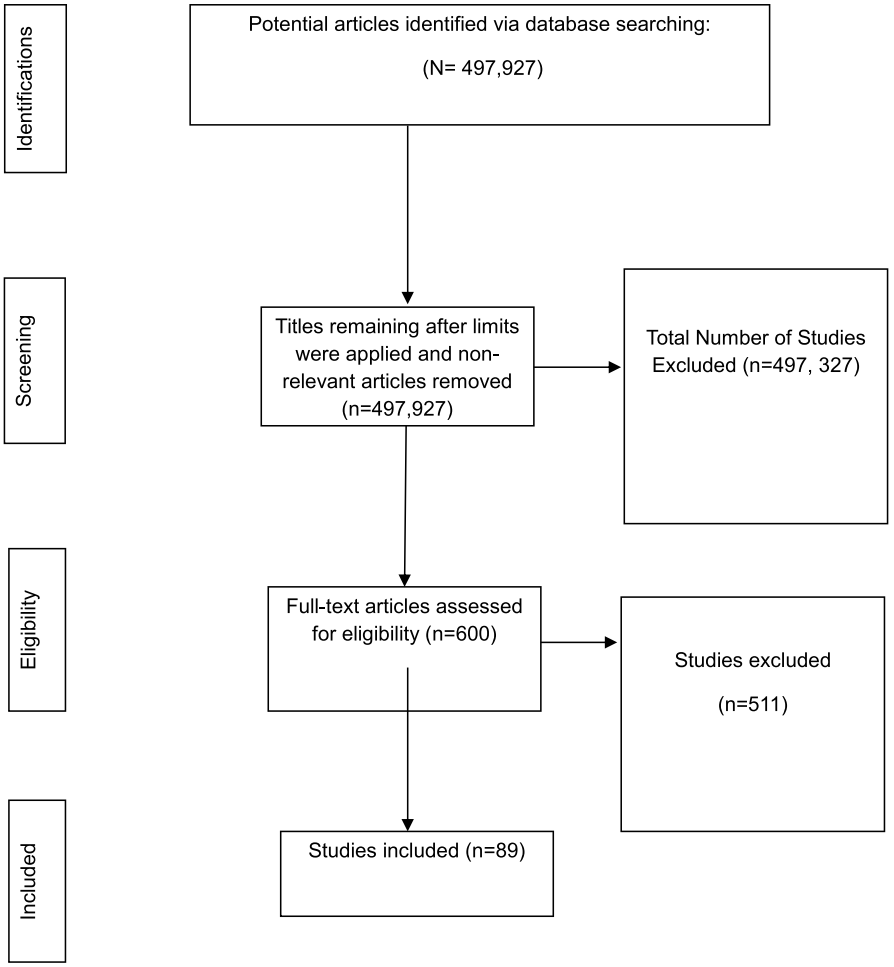

Fig. 1 Summary of article selection process

Article Characteristics

All articles were published between 2006 and 2021. Eleven articles covered concepts regarding definitions of UEC; ten discussed UEC Frameworks, and twenty-two examined the types of UEC formed. Twelve articles covered concepts relating to the formation of UECs; five discussed the timelines of events in UECs, and two articles covered concepts relating to measuring the success of a UEC. Twelve articles investigated critical factors in UEC; eleven discussed barriers to UEC; nineteen examined enablers of UEC. Three articles covered UEC policy availability, and ten covered good practices in UEC. It is pertinent to note that many articles covered more than one distinct concept. A summary of the concepts extracted from each article is presented in Table 2.

Table 2 Summary of article characteristics

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Albahari et al., 2019									X		X
Albats, et al., 2020				X				X			
Albors, 2002			X					X			
Al-Damen, 2021									X		
Anjum, 2020			X								
Ankrah & Al-Tabbaa, 2015			X	X							
Arundel et al., 2021				X			X				
Awasthy et al., 2020										X	X
Barbini et al., 2021				X							
Barker, 2004											
Bekkers & Freitas, 2008	X										
Bruneel et al., 2010								X	X		
Cai & Etzkowitz, 2020		X									

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Cai & Liu, 2015		X									
Cai, 2014		X									
Collier et al., 2011									X		
D'Hombres & Scnepf, 2021			X								
Dada et al., 2019			X								
Daly, 2011			X								
de Souza et al., 2017			X								
Dee et al., 2019									X		
D'Este, et al., 2013			X								
Edler & Yeow, 2016									X		X
Etzkowitz & Zhou, 2017		X									
Fernandes, et al., 2019					X	X					X
Fernandes, et al., 2015	X										

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Freitas et al., 2013				X			X				
Galloway et al., 2014			X								
Galvão et al., 2019	X										
Gorlach, 2017			X								
Groulx et al., 2021			X								
Guimón, 2013	X										
Hermosura, 2019		X									
Hogan et al., 2017				X							
Huang & Turner, 2018			X								
Hughes et al., 2014			X								
Iqbal et al., 2011								X			
Kim & Jang, 2021		X									
Kivimaa et al., 2019									X		

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Knockaert et al., 2014									X		X
Lahsen & Piper, 2019							X				
Lane & Rogers, 2011							X				
Larsen et al., 2016	X		X								
Leege & McMillan, 2016				X							
Leydesdorff & Ivanova, 2016		X									
Leydesdorff, 2012		X									
Lin & Bozeman, 2006	X						X	X	X		
Link & Scott, 2006									X		
Link & Scott, 2013									X		
Liu & Cai, 2018		X									
Liu et al., 2018									X		

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Liyanage, et al., 2020	X		X								
Löfsten et al., 2020									X		
Lopes & Lussuamo, 2021								X			
Maertz et al., 2014			X								
Marinho, et al., 2020					X		X				
Mathisen & Jorgsen, 2021			X								
Mores et al., 2019					X		X				
Myoken, 2013	X										
National Centre for Universities and Business [NCUB], 2021											X
Njau et al., 2019									X		
OECD, 2019											

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Okamuro & Nishimura, 2013							X				
Olivier et al., 2016			X								
Organisation for Economic Co-operation and Development [OECD], 2015							X			X	
Osafo & Yawson, 2019									X		
Patton & Marlow, 2011									X		
Pellegrini & Johnson-Sheehan, 2021									X		
Peterson, 2009	X										
Proulx et al., 2014											X
Rajalo & Vadi, 2017					X						

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Ramli & Senin, 2015				X				X			
Ranga & Etzkowitz, 2013		X									
Rybnicek & Königsgruber, 2019					X		X				X
Saniter & Siedler, 2014			X								
Schaeffer et al., 2020											X
Seppo & Roolaht, 2012									X		
Siegel et al., 2003	X										
Strier, 2014							X				
Tantanee, 2018	X		X								
Tartari et al., 2012							X			X	
Thomas & Paul, 2019									X		
Veletanlić & Sá, 2020									X		

Table 2 (continued)

Author(s), year	UEC definition	UEC frameworks	Types of UECs, and how they are formed?		Timelines of UEC	Measurements of UEC success	Considerations during the formation of UECs			UEC policies	Good practices
			Types of UEC	Formation of UEC			Critical factors	Barriers	Enablers		
Williamson et al., 2016				X			X				X
Wilson, 2012				X				X		X	X

Discussion

The review aimed to *s*ynthesise relevant findings regarding the processes, dynamics, and factors involved in the formation, maintenance, and governance of successful university enterprise collaboration (UEC) by addressing three research questions. In the context of UECs, the term *formation* refers to the factors involved in establishing a UEC. Accordingly, the first research question that this paper aimed to address was "*how are UECs formed*?". The analysis identified several critical concepts essential to understanding the formation of University-Enterprise Collaborations (UECs), including defining UECs, UEC frameworks, and the different types of UECs and the factors which influence their formation.

From the literature, it was revealed that there are no universally recognised definitions for the term 'university-enterprise collaboration.' However, the term 'university-industry partnership' (UIP) is commonly used in published literature and refers to the interaction between any section of the university system and industry to promote knowledge and technology exchange (Bekkers & Freitas, 2008; Siegel et al., 2003). That said, it is argued that this definition needs to be more specific and accurate (Fernandes, 2015), as the benefits of UIP can be unrestricted to a specific area of business or financial gain (Liyanage et al., 2020). For example, UIPs typically aim to capitalise on knowledge for financial gain. In contrast, non-government organisations (NGO)-university collaborations are typically concerned with achieving positive outcomes for social, human, environmental and economic development (Peterson, 2009). Therefore, the term university-enterprise collaboration (UEC) more effectively defines the concept of collaborations between universities and external organisations by encompassing the various stakeholders that can collaborate with universities to achieve a mutual goal. UEC can be defined as the interaction between any section of the university system and any external organisation to achieve a mutual goal.

There are many reasons for the formation of UECs, such as providing highly qualified researchers, graduates, and students (Myoken, 2013) and access to technology, knowledge, and innovative research infrastructure (Ankrah & Al-Tabbaa, 2015). Consequently, various frameworks have been developed to define the entrepreneurial capabilities of universities and guide the formation of UEC to maximise its potential (Mascarenhas et al., 2019). The most widely reported frameworks for UEC include the triple helix model (Etzkowitz & Zhou, 2017; Leydesdorff, 2012) and the human capital framework (Hermosura, 2019). However, more recently, the analytical framework of innovative action and dynamics model (AFIAD) (Kim & Jang, 2021) has been developed and may prove to be more helpful in developing UECs with stakeholders outside of industry via the integration of individual components, key relational and functional aspects that adapt to the changing environment (Kim & Jang, 2021). Therefore, when forming UECs, it is essential to consider the type of collaboration, as each involves unique processes and dynamics. As such, UEC frameworks should consider the various types of collaborations, as the processes and dynamics involved may differ according to the type of UEC. A summary of these frameworks is presented in Table 3.

Table 3 Summary of UEC frameworks

Framework	Description	Advantages	Limitations
Triple helix model	Typically represented as a Venn diagram, illustrating the overlap between the agencies involved. The intersections represent particular relations such as technology transfer, funding, or training/educational programs. The model provides a heuristic guide for various innovative projects	Exemplifies the relationships between universities, industry, and government and conceptualises the bilateral relations between industries and universities that may require government-enforced policy interventions (Leydesdorff & Ivanova, 2016) The model suggests that all stakeholders involved with the triple helix engage in their activities and those of others, thus allowing practical collaborative activities to capitalise on knowledge (Ranga & Etzkowitz, 2013)	This model is vague as it does not provide descriptive or analytical elements to assess or evaluate UEC (Cai, 2014; Liu & Cai, 2018) Does not demonstrate contextual sensitivity across cultures and settings (Cai & Liu, 2015). Therefore, its versatility regarding different types of UEC and the context in which they are conducted is questionable since the model may not effectively capture the complex dynamics between stakeholders as intended It views academia as vital for capitalising on knowledge and ignores the contribution of other stakeholders. It should not be underestimated, as government and industry stakeholders are also substantially involved in translating knowledge into actionable policies, products, or interventions (Lane & Rogers, 2011)
Triple helix of human capital development	Elucidates the trilateral relationship between universities, government, and industries that can interact harmoniously to achieve ambitious socio-economic ventures and emphasises the economic benefits of UEC and the social benefits of effective UEC	Makes practical suggestions. For example, governments should incentivise enterprises, allocate funding, and devise policies to promote and enhance UEC according to socio-economic demands to deliver economic growth	Despite highlighting stakeholders' contributions, this framework fails to account for the interaction between individual stakeholders and the function of the collaboration
AFIAD	Incorporates formal factors, action dynamics, and outcomes into a single model and permits the visualisation of essential elements and sub dynamics of UEC	Considers the dynamics, formal factors and outputs encompassed within a UEC Can be used for the evaluation of UECs	Does not consider stakeholders outside of industry, such as NGO's May not demonstrate sensitivity in different types of UEC and between different stakeholders

Existing frameworks currently lack practical guidelines. In other words, existing frameworks describe theoretical models, yet they do not delineate the tangible actions that are required to form, maintain, and govern UECs. Existing UEC frameworks also exhibit limitations in their applicability to diverse stakeholders (Awasthy et al., 2020). Frameworks typically focus on economic or technological outcomes (Awasthy et al., 2020). Consequently, existing frameworks may be ineffective for UECs that aim to address broader societal goals, such as public health, education, or sustainability.

The formation of UECs is generally orientated around several distinct types of UEC including, knowledge transfer, co-research, internships, and student exchanges (Liyanage et al., 2020). Knowledge transfer between universities and enterprises creates a support network that ultimately drives innovation, economic growth, and prosperity (Ankrah & Al-Tabbaa, 2015). Knowledge transfer is an area of specialisation in many industries that provides differentiated knowledge and learning that can be utilised to inform decisions that ensure excellence (Thomas & Paul, 2019). However, it is assumed that universities are the sole generators of knowledge within knowledge transfer UECs, which ignores other enterprises' knowledge. That said, co-research UECs may help to correct this assumption.

Research collaborations facilitate learning processes between stakeholders, resulting in both intended and unintended knowledge transfers (D Este Cukierman et al., 2013). In academia, knowledge is often tacit, but co-research collaborations allow knowledge to be shared between stakeholders, which creates new value (Maertz et al., 2014). Research highlights the importance of uniting stakeholders from different organisational backgrounds to gain new perspectives, strategies, and ideas to drive novel innovations (Ranga & Etzkowitz, 2013). Due to the emphasis placed on government and industry stakeholders in existing models, smaller businesses and NGOs may have been somewhat overlooked within UECs. University-NGO collaborations have been beneficial for sustainable development (Groulx et al., 2021), public health (Dada et al., 2019; de Souza Lessa et al., 2017), and disaster resilience (Jones et al., 2016). Forming academic-NGO collaborations can broaden the impact of UEC (Williamson et al., 2016), generate opportunities to develop communities (Mores et al., 2019), and produce knowledge (Barker, 2004). As such, university-NGO collaborations can provide services demanded by the local community and create opportunities for assimilating knowledge utilised in daily life (de Souza Lessa et al., 2017).

Student exchanges develop graduates' intercultural and international knowledge (Daly, 2011) and allow students to develop professional skills and practical experience within an enterprise (Hughes et al., 2014). The advantages of forming student exchange collaborations include increased employability prospects (Daly, 2011; Huang & Turner, 2018; Kapareliotis et al., 2019; Saniter & Siedler, 2014), a skilled workforce (d'Hombres & Schnepf, 2021; Gorlach, 2017), enhancing social and cultural capital (d'Hombres & Schnepf, 2021; Hughes et al., 2014) and low-cost recruitment and labour (Galloway et al., 2014; Maertz et al., 2014). Furthermore, universities benefit from strengthened networks with enterprises, increased funding availability, and enhanced student employability (Anjum, 2020). As such, the type of UEC may affect their formation and is contingent upon the needs of both

the university and enterprise. However, no existing framework recommends specific channels by which different types of UECs can be initiated, which may hinder the formation of UECs. Therefore, it is pertinent to consider the type of UEC sought and the most appropriate channel for initiating a particular UEC.

Generally, the formation of UECs can be achieved via several channels, though these channels are generally categorised as formal or informal. Formal agreements are often established between universities and enterprises to achieve a mutual goal and affirm each stakeholder's role and contributions to the collaboration, including resources, funding, and workforce (Schaeffer et al., 2020). Formal channels and procedures for the formation of UECS should be established to ascertain accountability, conflict resolution, and strategies to mitigate potential extenuating circumstances.

Most UECs are initiated by faculty via informal social contacts and informal arrangements regarding the grounds for conducting the project (Barbini et al., 2021; Tantanee et al., 2018; Wilson, 2012). That said, research has indicated that organisations that rely on informal personal contacts as a means for establishing UEC are typically smaller with lower levels of absorptive capacity (Freitas et al., 2013), which may limit the success of a UEC. In turn, this may also present a significant issue in low- and middle-income countries where organisations may lack sufficient absorptive capacity (Arundel et al., 2021), and thus limit their accessibility to UECs. Consequently, it is considered good practice for stakeholders to exercise transparency when developing a collaboration to ascertain their capacity and capabilities for research and knowledge absorption (NCUB, 2021).

Nonetheless, informality can lead to conflicts between stakeholders involved in the collaboration (Schaeffer et al., 2020). Several conflicts are known to limit the success of UEC formation, including conflict of interests, lack of continuity of evaluative processes, poor planning and implementation, bureaucratic limitations, ambiguity regarding the viability of suggested outcomes, conflicting values, and competition for resources (Strier, 2014). Though, it should be noted that there are relatively few articles that explore informal channels for UEC formation (Barbini et al., 2021). However, formal channels, such as science parks and incubators, are well-documented in literature (Albahari et al., 2019; Link & Scott, 2017; Löfsten et al., 2020).

Science parks are clusters of technology-based organisations near university campuses that benefit from university research and knowledge transfer (Link & Scott, 2017). Arguably, science parks reduce barriers for entrepreneurs by providing collaborative networks and resources which enhance start-up survival rates (Link & Scott, 2006). For example, science parks facilitate the interaction between stakeholders and provide a strategy for enterprises to establish collaborative networks (Albahari et al., 2019; Löfsten et al., 2020). As a result, science parks attract investment and talent and enable local regions to become globally competitive centres of high-tech industries and advanced research. (Löfsten et al., 2020).

Similarly, incubators are functional spaces hosted by universities that facilitate the launch of start-ups by professors, students, researchers, and local entrepreneurs (Pellegrini & Johnson-Sheehan, 2021). Incubators typically offer networking opportunities for enterprises interested in collaborative work, access to specialist facilities, and general support and mentoring for start-ups and spin-offs (Collier et al., 2011). Consequently, the success of incubators has been

documented widely and is considered an enabler of successful UECs (Al-Damen, 2021; Dee et al., 2019; Njau et al., 2019; Patton & Marlow, 2011).

Evidence suggests that reciprocal knowledge transfer between universities and enterprises enhances innovation and competitiveness and can be facilitated via science parks (Link & Scott, 2012). As a result, science parks have been commended for contributing towards economic growth and development (Collier et al., 2011). That said, scholars have conductive extensive comparative research between science parks and have deduced that in order for a science park to be successful, it must address several critical elements (Etzkowitz & Zhou, 2018). These elements include geographical proximity to research resources, space for new firms; effective managers with a knowledge of science park activities; and facilities and infrastructures to attract entrepreneurs, effective university and government policies, sufficient venture capital and a pool of interested entrepreneurs (Etzkowitz & Zhou, 2018; Link & Scott, 2017).

Innovation policy plays a central role in the formation and success of science parks and incubators by creating an environment conducive to innovation and entrepreneurship (Etzkowitz & Zhou, 2018; Link & Scott, 2017). For example, governments and policymakers typically support these initiatives by offering R & D and innovation subsides or grants, tax incentives, financial support for academic spin-offs, grants for intellectual property applications, financial support to recruit PhDs or post-docs, financial support to host industry partners, innovation vouchers, funding of infrastructures, and intermediaries (OECD, 2019).

In the context of UECs, the term *maintenance* refers to the factors involved in sustaining end successfully executing a UEC. The second research question that this paper aimed to address was "*How are UECs maintained*?" The analysis identified several critical concepts essential to understanding the factors which contribute to the maintenance of UEC's, including timelines of UEC, measurements of UEC success, critical factors, enablers and barriers to UEC success.

Literature exemplifies two distinct phases in the development of UEC and includes a formation and maintenance phase. It is suggested that during the formation phase, all stakeholders must seek partners that hold corresponding objectives, motivations, and skills (Marinho et al., 2020). During the maintenance phase, frequent and ongoing involvement between stakeholders and ongoing evaluation are essential to ensure success (Marinho et al., 2020). However, both of these phases are believed to be fundamental for the overall success of the UEC (Marinho et al., 2020). That said, researchers have devised a timeline which incorporates sustainability factors that are important to the success of a UEC at each phase of the process (Rajalo & Vadi, 2017; Mores et al., 2019). Therefore, it could be argued that the timeline of a UEC is comprised of three stages.

The stages of a UEC typically consists of a pre-collaboration stage, a 'during' or active collaboration stage, followed by a post-collaboration stage (Rajalo & Vadi, 2017; Mores et al., 2019). There is no established timeline for forming a UEC, but from the evidence identified it can be suggested that the timeline of a UEC begins at the pre-collaboration stage, during which collaborating stakeholders are identified and mutual goals and working agreements are established

(Mores et al., 2019). Once consensus is reached between all stakeholders, a formal agreement can be made and then the active collaboration stage can begin.

During the active stage of a UEC, stakeholders can attend to their roles and responsibilities as agreed. However, evidence suggests that ongoing monitoring and evaluation of progress is essential to ensure that the UEC is effectively maintained (Fernandes et al., 2019). It should also be noted that relational factors such as effective communication, transparency and accountability should be maintained throughout the duration of the project (Rybnicek & Königsgruber, 2019). That said, these factors may demonstrate greater significance during the active stage of the collaboration process.

During the post-collaboration stage, a final evaluation of the UEC process would be beneficial to allow stakeholders to reflect on their overall experience (Fernandes et al., 2019). This reflection can allow stakeholders to identify barriers that have impacted the process, but also enabling factors that have enhanced the UEC (Fernandes et al., 2019). Consequently, stakeholders can address their areas of concern and utilise this part of the process to improve their own strategies for ensuring effective UECs (Fernandes et al., 2019). Furthermore, a final evaluation would permit stakeholders to consider the advantages and disadvantages of UEC in relation to their own ambitions and capabilities (Fernandes et al., 2019). A summary of the timeline for the UEC process is illustrated in Fig. 2.

An extensive review of business-university collaboration has revealed several factors that may limit the maintenance of collaborative projects, including disparities between the aims of stakeholders and failure to meet agreements within the expected timelines (Marinho et al., 2020; Rajalo & Vadi, 2017; Rybnicek & Königsgruber, 2019; Wilson, 2012). Whilst extenuating circumstances may impact the project timeline, contingency plans and resources should have already been established by each stakeholder from the offset to mitigate these circumstances when they arise. Furthermore, active engagement within a collaboration is also considered a good practice within UEC as it enables issues to be identified and resolved (NCUB, 2021).

Although the timeline for the formation of UEC seems relatively straight forward, there are a number of barriers that can prevent or hinder the UEC process, thus limiting the effectiveness of the UEC. These barriers are typically categorised as orientation-related barriers and resource-related barriers (Bruneel et al., 2010; Seppo & Roolaht, 2012; Tartari et al., 2012). Orientation-barriers encompass any barrier that arises as a result of differing ethe between stakeholders (Tartari et al., 2012). It is generally accepted that universities focus more on generating new knowledge, whilst

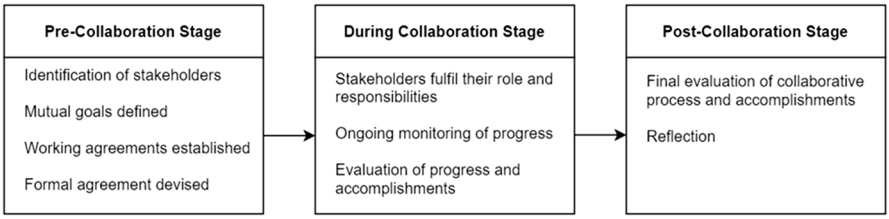

Fig. 2 Timeline of UEC

enterprises typically focus on gaining financial indemnities from research activities (Iqbal et al., 2011). As a result, barriers may arise from asymmetry in motives between organisations (Lopes & Lussuamo, 2021). On the other hand, resource-related barriers, typically encompass any barrier relating to the availability of resources (Tartari et al., 2012). Whilst the resources required for a UEC are largely determined by the nature of the collaboration itself, they typically include financial, human, and infrastructural resources that are necessary to maintain the project to the point of completion.

Financially, universities generally rely upon funding from government and private sectors to conduct research activities, although, the majority of funding is provided by the government (Wilson, 2012). In turn, this creates barriers for universities to implement applied or developmental research, as governments typically fund only fundamental and pressing research (Shapiro, 2013). Whilst this is an obvious barrier to UEC, it also highlights the necessity of encouraging UEC to permit the expansion of academic knowledge to sectors outside of academia. In addition, human resources are consistently documented within published literature, as they are believed to be vital for the formation and sustainability of a UEC (Ramli & Senin, 2015). Human resources refer to the skills, knowledge, experience, and personal characteristics of the workforce within an organisation. It is recognised that these components within human resources are vital for effective UEC (Albats et al., 2020). As a result, issues with human resources can create detrimental barriers to the effectiveness of a UEC. That said, infrastructural barriers can also diminish the effectiveness of a UEC. Therefore, the lack of sufficient infrastructure may create barriers to effective UEC (Wilson, 2012).

Although the formation of UEC seems straightforward, maintaining effective UECs is a somewhat intricate process. Literature has revealed several barriers that can hinder the maintenance of UECs, which are typically categorised as orientation-related barriers and resource-related barriers (Bruneel et al., 2010; Seppo & Reino, 2012; Tartari et al., 2012). Resource-related barriers typically encompass any barrier relating to the availability of financial, human, and infrastructural resources (Tartari et al., 2012). Orientation barriers arise due to differing ethe between stakeholders (Tartari et al., 2012). It is generally accepted that universities focus more on generating new knowledge, whilst enterprises typically focus on gaining financial indemnities from research activities (Iqbal et al., 2011). As a result, barriers may arise from organisations' asymmetrical motives (Lopes & Lussuamo, 2021).

Relationships between stakeholders are built upon mutual trust and respect for the abilities of individuals within the collaboration (Awasthy et al., 2020; Hogan et al., 2017; Williamson et al., 2016). That said, research has highlighted the role of human resources in knowledge transfer UECs (Castro-Casal et al., 2013; Lin & Bozeman, 2006). Human resources are consistently documented within published literature as vital for the sustainability of UECs (Castro-Casal et al., 2013; Lin & Bozeman, 2006; Ramli & Senin, 2015). Human resources broadly encompass the skills, knowledge, experience, and personal characteristics of the workforce within an organisation (Albats et al., 2020). As a result, issues with human resources can limit the success of UECs, but human capital development can enable effective UECs (Lin & Bozeman, 2006).

Human capital can be developed through various channels, with student exchanges and internships offering a viable route for this development. Human resources can enable UEC by expanding formal and informal networks (Osafo & Yawson, 2019) and individual skill sets (Coleman & Lang, 2012). Human resources can also be utilised via intermediaries, such as agents or brokers, by linking academic and business organisations and providing an interface between the two (Edler & Yeow, 2016; Knockaert et al., 2014). Intermediaries establish and mediate relationships between stakeholders, and bridge knowledge, capabilities, and competencies (Edler & Yeow, 2016).

Intermediaries establish and mediate relationships between stakeholders, and bridge knowledge, capabilities, and competencies (Edler & Yeow, 2016). Intermediaries do not have any vested interests within the collaboration but enable effective UEC by encouraging co-creation and innovation amongst stakeholders (Kivimaa et al., 2019). Intermediaries can prevent some barriers from arising and may also assist in overcoming these barriers whilst ensuring effective communication between stakeholders. The value of intermediaries has been documented in published literature and has subsequently been considered good practice for UEC (Knockaert et al., 2014). The value of intermediaries has been documented in published literature and has subsequently been considered good practice for UEC (Knockaert et al., 2014).

In the context of UECs, the term *governance* refers to the processes and regulations involved in the management of a UEC. The third research question that this paper aimed to address was "*How are UECs governed*?" The analysis identified several critical concepts essential to understanding the factors which contribute to the governance of UEC's, including measuring success, funding, policies, and intellectual property (IP) rights.

Preliminary research has identified a set of performance indicators that are believed to accurately assess the success of UECs at each collaboration stage (Fernandes et al., 2019). The Method for Measuring the Performance of University-Industry Collaborations (MPUIC) (Fernandes et al., 2019) comprises a series of evaluation points assessed at four-time points throughout UECs, including program preparation and program initiation, program benefits delivery, program closure, and post-program. Whilst the MPUIC (Fernandes et al., 2019) may demonstrate utility for assessing the success of UIP, the sensitivity of the MPUIC may need to be improved for UECs. Furthermore, the MPUIC may ineffectively quantify the success of a UEC that is orientated around societal or public health outcomes due to its focus on financial gain and technological achievements.

UECs have demonstrated great success in humanitarian, educational, and public health initiatives, but their success would be underestimated if quantified using the MPUIC (Fernandes et al., 2019). Hence, this evaluation tool ignores the diverse range of UECs that address issues beyond economic growth. There is a need for a tool that considers the various definitions of success. The need for a quantitative tool to reliably measure and compare the success of UECs has been highlighted in literature (Fernandes et al., 2019; Fernandes, 2015). It may be beneficial for stakeholders to convey their vision of successful collaboration at

the pre-collaboration stage, allowing the collaboration's success to be evaluated subjectively.

UECs typically end upon the completion of the project. However, maintaining collaborative networks post-completion for continuity or extension of projects is considered a good practice as it can facilitate future development and innovation (Fernandes et al., 2019; OECD, 2019). Nevertheless, future prosperity depends on inclusive growth and the generation of intended outcomes. Therefore, good practice would involve a final evaluation of the collaboration, emphasising reflection and constructive feedback for improving future UECs (Fernandes et al., 2019).

Investment in collaborative work can be derived from various channels such as governments, private investors, NGOs, non-profit organisations, and research councils. Irrespective, funding should be secured and discussed before the collaborative work begins, as sufficient funding ensures that the collaboration can be adequately maintained throughout its duration (Proulx et al., 2014; Wilson, 2012). Financially, universities generally rely upon government and private sector funding to conduct research activities, although most funding is provided by the government (Albors, 2002; Wilson, 2012). As governments typically fund only essential research, this creates barriers for universities to embark upon applied research collaborations (Bloom et al., 2019).

Governments are a significant stakeholder within UEC and are responsible for the development and implementation of laws, policies, and regulations for UEC. As a result, UEC can be enabled by the level of support provided by the government in terms of the effectiveness of the policies for UEC, financial support, and investment and regulations regarding intellectual property (Liu et al., 2018; Valetanlić & Sá, 2020). The development and implementation of effective policies at an institutional and government level are considered good practices for UEC (Liu & Cai, 2018; OECD, 2019; Veletanlić & Sá, 2020). However, bureaucratic procedures for obtaining funding can hinder the timely completion of UECs and is a substantial source of conflict between stakeholders (Rybnicek & Königsgruber, 2019). Therefore, involving all stakeholders in allocating and managing expenditure and investment whilst exercising transparency and accountability increases UEC success (Rybnicek & Königsgruber, 2019).

Despite developing and implementing laws, policies, and regulations for UEC, policymakers have been criticised for not explaining how these policies can be implemented (OECD, 2015). As a result, the OECD (2019) conducted an extensive review to assess policy impacts on knowledge transfer. The review revealed several policy instruments that researchers, universities can utilise, and enterprises to promote and enhance UEC (OECD, 2019). The categories of policy instruments broadly cover every critical area of UEC, including funding, intellectual property rights, and awareness building (OECD, 2019). As a result, a comprehensive taxonomy of policy instruments has been devised and disseminated widely to various stakeholders (OECD, 2019). Notably, the taxonomy recommends that knowledge transfer policies for UEC should be specifically tailored to enterprise and research requirements, as their relevance varies across countries, fields, and sectors (OECD, 2019). However, revisions to policies and regulatory procedures for funding procurement may

be necessary to circumvent bureaucracy and assist in the successful governance of UECs.

Intellectual property issues within UEC have been well-documented within literature as a significant barrier to successful UECs (Kafouros et al., 2015; Liu et al., 2018; Okamuro & Nishimura, 2013; Veletanlić & Sá, 2020). There are policies in place to establish intellectual property rights, but a review of these policies has found significant variations in the implementation of legislation (Arundel et al., 2021). Developing and implementing intellectual property regulations are further complicated by varying policies, regulations, and laws between countries (OECD, 2015). As a result, international collaborations may generate more difficulties when ascertaining intellectual property rights between stakeholders (Ahmed Lahsen & Piper, 2019). Therefore, it is pertinent to consider each stakeholder's expectations regarding outcomes and ascertain how to manage indemnities and liabilities such as intellectual property (Wilson, 2012). A failure to reach a consensus regarding intellectual property rights will limit UEC's success (Rybnicek & Königsgruber, 2019; Williamson et al., 2016; Wilson, 2012).

Conclusions

The findings from this integrative review highlight the complexities within UEC literature. The current body of research is fragmented, with studies typically focusing on isolated aspects of UEC, such as policy, funding, or performance metrics (Awasthy et al., 2020). This lack of cohesiveness suggests that an incomplete understanding of UECs persists, as the literature often fails to capture the multifaceted realities that impact collaborative success. Therefore, there is a need to develop frameworks that are applicable to an array of motivations, objectives, and organisational structures beyond financial and technological gain. In turn, the development of effective frameworks may broaden the range of stakeholders involved in UECs and thus, diversify UEC impact by aligning with societal as well as financial and technological requirements (Tucker et al., 2024).

Evaluating UEC success remains challenging due to the lack of standardised measures. An adaptable evaluation approach, combining qualitative and quantitative metrics, could better capture varied forms of success. Future research should establish a reliable framework to measure progress over time, encompassing less tangible outcomes such as stakeholder satisfaction, relationship quality, the development of collaborative networks and broader social impact as well as tangible outcomes, such as patents or publications. This would enable UECs to demonstrate both economic and societal achievements as well as relational outcomes. In turn, the effective evaluation of UECs may solidify their role in driving innovation and addressing societal challenges.

Financial barriers further hinder successful UECs, as universities often rely on government funding that typically prioritises fundamental research over applied, community-focused projects. This creates a funding gap and limits diversity amongst UEC stakeholders. Therefore, there is a need for diversified support from governments, research councils, private investors, and NGOs. Stakeholders

could also benefit from contingency planning to navigate funding shortfalls or delays, whilst diversified funding models may support applied UECs in maximising societal impact.

Effective policies are essential to UEC success, but knowledge transfer policies should be adaptable to different sectors and regions. Simplifying policies, particularly around funding and project management, could reduce bureaucratic delays and thus facilitate successful UECs. Flexible regulatory frameworks are also necessary to accommodate diverse enterprise requirements and cultural differences amongst stakeholders.

Finally, it was evident from the literature identified that there is a lack of human-centered perspectives in UEC. Research exploring the experiences and perspectives of both academic and management staff could uncover less salient barriers to effective UECs, as well as potential solutions. Additionally, such research could highlight the factors which motivate, and those that discourage academics from engaging in collaborative projects with enterprises. Therefore, to advance UEC research, future studies should utilise methods which capture real-world insights into how UECs are formed, maintained, and governed. In turn, these findings may bridge the gap between theory and practice, as what works in theory does not always work in practice.

Acknowledgements This project has been a collaborative effort involving several partner universities across Europe, Sri Lanka, Thailand, and the Philippines. In particular, I would like to acknowledge the leadership and contributions of Mid-Sweden University (Sweden–Lead), Tallinn University (Estonia), University of Central Lancashire (UK–Co-Lead), and University of Huddersfield (UK). I also appreciate the vital contributions of our partner institutions in Sri Lanka—University of Ruhuna, University of Peradeniya, and University of Sri Jayewardenepura; in Thailand—Chiang Mai University, Naresuan University, and Mahasarakham University; and in the Philippines—Ateneo de Manila University, Philippine Normal University, and Malayan Colleges Laguna. Their collaboration, expertise, and dedication have been fundamental to the success of this international project. I would also like to express my heartfelt gratitude to Prof. Champika Liyanage and Dr. Sarita Robinson for granting me the incredible opportunity to work alongside them and for their unwavering encouragement and support throughout this journey. Their faith in my abilities and their commitment to nurturing my growth as a researcher have been truly inspiring. Their guidance and belief in me have not only made this work possible but have also played a pivotal role in shaping my confidence and development in the field. I am deeply grateful for their mentorship and for the opportunity to contribute to this project and see it through to publication.

Author Contribution All authors played a role in the conceptualisation and development of the manuscript. The first draft of the manuscript was written by RT. CL and SR provided significant assistance throughout the process, contributing to the refinement and finalisation of the manuscript. The collective contributions of all authors were essential in shaping the direction and quality of the final manuscript.

Funding This paper is funded by ERASMUS + project titled "SECRA-Strengthening University-Enterprise Collaboration for Resilient Communities in Asia" (Grant Agreement No. 6 l 9022-EPP- l-2020- l-SE-EPPKA2-CBHE-JP).

Data Availability No new data were created or analysed in this study. Data sharing is not applicable to this article.

Declarations

Conflict of Interest The authors declare no competing interests.

Ethical Conduct This study is compliant with ethical standards.

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