

# The system effects of linkages on actor disposition and resource density: an approach to university-industry linkages

The system effects of linkages

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Received 24 May 2022  
Revised 11 November 2022  
Accepted 17 February 2023

## Abstract

**Purpose** – Linkages play a strategic role in improving actor disposition and resource density in university–industry ecosystems. Due to the importance of interconnected ecosystems for the development of engaged universities, applying the service-dominant logic (SDL) perspective, the authors aim at developing theory on linkages that lead to a higher level of actor commitment and in turn result in increased actor disposition and greater resource density.

**Design/methodology/approach** – Data from semistructured interviews from four in depth case studies, known internationally as successful cases of university linkages development (Columbia Lab-to-Market Accelerator Network, Oxford University Innovation, Auckland Uniservices and the Münster Center for Interdisciplinarity), undergo qualitative analysis according to the Gioia methodology.

**Findings** – The results represent a contribution to the theory, as they highlight the strategic role of linkages in improving actor disposition and increasing resource density. Due to its shown importance, linkage is an element to be considered on its own in the innovation ecosystems configurations in the context of universities.

**Practical implications** – The results of the research have implications for university management, since they focus on how resources are mobilized and linked. The interactive roles of actors in ecosystems imply that the locus of value creation moves beyond the borders of the organization toward the linkages. Strategies for managing university–industry linkages (UIL) are presented.

**Originality/value** – To date there has not been sufficient theoretical or empirical contribution in the university–industry ecosystem context about the role of linkages to improve resource density through increased actor disposition.

**Keywords** Ecosystems, Service-dominant logic, University–industry linkages, Actor disposition, Resource density

**Paper type** Research paper

## 1. Introduction

The systemic approach to the market (Pels *et al.*, 2022; Vargo *et al.*, 2023) represents a growing trend for research that gives answers to the changing structures that actors manage with roles that are not clearly defined (Koskela-Huotari and Siltaloppi, 2020; Wieland *et al.*, 2016). This approach gives space to new and more dynamic conceptualizations of the market (Mele *et al.*, 2015; Pels *et al.*, 2022) and results in a different way of co-creating value, relying on networks (Plata *et al.*, 2021; Scott *et al.*, 2022) and collective engagement (Kleinaltenkamp *et al.*, 2019), increased actor disposition and resource density (Storbacka *et al.*, 2016). In this context, little attention has been paid to the linkages among actors as a key factor, responsible for connecting these actors and facilitating network connection, actor disposition and resource density.

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This study was financed by the Ministry of Universities (Government of Spain) (FPU20/07018).



International Journal of  
Entrepreneurial Behavior &  
Research  
Emerald Publishing Limited  
1355-2554  
DOI 10.1108/IJEBR-05-2022-0464

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Recent literature highlights the need for adopting a network (many-to-many) ecosystem perspective on management (Marciel and Fischer, 2020; Scott *et al.*, 2022; Vargo *et al.*, 2023), and in this perspective, the service-dominant logic (SDL) has emerged as a general theory of markets (Akaka *et al.*, 2021), capable of framing business models that better meet the needs of growing market interconnection.

In the last 30 years, universities have undergone a major transformation in order to adapt to a context in which open innovation is changing actors, organizations and connections among them (Bergebale-Mirabent and Ribeiro-Soriano, 2015; Plewa *et al.*, 2019). In the university entrepreneurial context, the approach from the ecosystem perspective has adopted the terminology of university–business ecosystem (Chryssou, 2020; Clauss *et al.*, 2018; Polese *et al.*, 2021; Quero *et al.*, 2022). This process has been accompanied by a recent increase in academic contributions that analyze the role of universities as central drivers of knowledge-based economies (Audretsch, 2014; Etkowitz, 2017; Hasche and Linton, 2021; Polese *et al.*, 2021). Guerrero and Urbano (2012, 2019) developed an in-depth approach to the entrepreneurial university and, more recently, Moussa *et al.* (2019, p. 36) linked the concept of the “engaged university” to “entrepreneurial university”. In the same vein, Kliewe *et al.* (2019) referred to the term “engaged university” in order to rediscover the concept of “engaged”, in an interesting modern approach to managing relationships among actors in the higher education sphere. These terms have had a parallel evolution. Both have attracted growing research from academic and public organizations, with rising levels of theoretical and empirical knowledge in this area. In turn this has demanded even more studies in the field as “research on engaged universities is currently rather seldom to be found in higher-ranked scientific publications” (Moussa *et al.*, 2019, p. 20).

On a parallel path, “actor engagement” (AE) is recently beginning to consolidate as a research branch framed on SDL ecosystem approach. Brodie *et al.* (2019) propose a broadened conceptual domain of AE in networks that breaks with the traditional customer and dyadic perspective of the relationships (built around customer engagement) to introduce the actor-to-actor and network perspective (Vargo and Lusch, 2011, 2017). On the SDL-ecosystem approach, Tronvoll (2017) emphasizes that an open, socially constructed dynamic system can be theoretically broken down into actors, linkages and context. And more recently, Grandstrand and Holgersson (2020) make specific reference to the “linkages through relations” in connecting actors with resources in innovation ecosystems. From this perspective, literature has given a growing recognition to the mediating strategic role of linkages. In the university context, university–industry linkages (UIL) have been well-recognized as a key topic (D’Este and Patel, 2007; Filippetti and Savona, 2017; Plewa *et al.*, 2019; Puerta-Sierra and Jasso-Villazul, 2018). However, previous approaches lack a systemic approach such as the SDL and AE perspectives that would highlight their strategic role in improving resource density in their systems, and that could give the theoretical support needed to generate models and develop theory. Also lacking are the corresponding strategies needed to maximize actor engagement, actor disposition and finally university system resource density.

Drawing on SDL and AE theory, the present paper re-defines the conceptualization of UIL from an SDL and AE perspective and considers them as a strategic mediating factor that “can generate significant tangible and intangible benefits by combining a university’s specialized knowledge and human resource with industry expertise” (Korff *et al.*, 2014, p. 213). From the same perspective, Plewa *et al.* (2019) highlight how the strong interest from both academics and industry on the role of linkages contrasts with the contributions that “fail to take into account the complex and dynamic nature of relationships” (p. 128). We focus on the linkages between university–industry and not on the interaction with other actors in the university ecosystem because the relevance and complexity of this particular context require a specific empirical approach.

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The present paper aims at filling this gap, presenting a novel approach that allows for the development of theory on UIL<sub>2</sub> through the adoption of a holistic view that brings SDL and AE perspectives to make a contribution to the university–industry relationship arena. Thus, the research question to be addressed by the present paper is.

*RQ1.* What is the role of UIL in relation to actor disposition and resource density in university–industry ecosystems?

An inductive approach is adopted with Gioia methodology, a qualitative methodology in order to meet the mismatch between the existing literature and operative practices in the university ecosystem. Following Brodie and Peters (2020), the empirical approach frames the midrange theory, which is “context-specific[. . .]and provides frameworks that can be used to undertake empirical observation and models to guide managerial practices” (p. 2). This perspective identifies the theory-practice gap (Fendt *et al.*, 2008; Gummesson, 2017; Nenonen *et al.*, 2017) that the present paper aims to cover.

The remainder of the present paper is organized as follows: first, approaching the study from an ecosystemic perspective, we build on the SDL and AE theory to offer a glance at the university ecosystem and its engaged actors, connecting with the concept of actor disposal. Then, we undertake a literature review to find the right conceptualization of actor disposition; resource density and the channels to improve its management in the university context. Third, we define the relevance of UIL, bringing the SDL and AE perspectives and re-conceptualizing the content. Following the theoretical framework, we present the qualitative methodology applied, describing the case selection, data collection process and analysis, based on axial coding. The key findings on the relation between UIL, actor disposition and resource density are outlined, and subsequently synthesized into a proposed university resource density (uRD) management model. We conclude the article with a discussion of the results, implications for theory and practice and a future research agenda.

## 2. Theoretical framework

### 2.1 University ecosystem: the context

Higher education, and specifically universities, have a long tradition on the need for being managed as an ecosystem (Audretsch and Belitski, 2021; Neumeyer and Santos, 2018; Theodoraki *et al.*, 2017). Universities are aware of this fact and, in the last years, they have increased their efforts to transform their management into this new perspective. Specifically, they answer this need going beyond the original triple helix (Etzkowitz, 2003, 2016) or quadruple helix (Cunningham *et al.*, 2018) perspectives to integrate actors in a context of open economy in which resources and innovation are connected by the ecosystem conceptualization (Schlegel *et al.*, 2022; Shi and Shi, 2022).

The ecosystem approach in the university context offers a certain consensus on the key actors that co-create value. Etzkowitz (2017, p. 227) refers to the “triple helix actors”, as a reference to the entrepreneurial university and Clauss *et al.* (2018) design a classification in which seven actors are identified: the university itself, academics, economy and society, new ventures, existing firms, students and administrators and coordinators. In a similar perspective, Feldman *et al.* (2019) refer to actors in the university ecosystem, including: faculty, post-docs, students, alumni, technology transfer offices, science and technology parks, incubators/accelerators, venture capitalists and angel investors, alumni commercialization funds and plethora of entrepreneurship programs and centers on campus.

Although literature defines the ecosystem actors with different structures, the essence of considering the university as an ecosystem that connects actors and resources is a common perspective in recent literature. As Guerrero and Urbano (2012, p. 47) posit: “Universities themselves are increasingly collaborating, networking and partnering with

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multiple industries, universities, private or public institutions in a national and international context". The ecosystem conceptualization of the university puts the focus on how actors' resources connect to each other. Neumeier and Santos (2018, p. 4566) conceptualize the entrepreneurial ecosystems as "complex adaptive systems of interdependent actors that engage in entrepreneurial activities to create economic, social as well as environmental value". This concept is coherent with the SDL perspective adopted in the present paper and allows for a proper understanding of the kind of network in which engaged actors exchange resources.

From the SDL perspective, the service ecosystem is defined as a "relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo and Lush, 2016, p. 10), and the ecosystem is the unit of analysis for value co-creation among actors in its sphere. This perspective is positioned also with recent works such as that of Audretsch and Belitski (2021), that call for the need of a new business model approach for universities. In this vein, the authors' "three ring approach" goes beyond the triple or quadruple helix model and propose to integrate "the university's role in engaging with university stakeholders at the individual, organizational and ecosystem levels in order to develop a competitive value proposition to external stakeholders" (p. 983). Our research is based on this ecosystemic approach and aims at shedding light at UIL as a key factor connecting actors and exchanging resources in this new open competitive context. We will apply this systemic approach to frame our research as it conceptualizes the university as a service ecosystem, in coherence with the RQ1 posed. This represents one step ahead, breaking free from the university-business collaboration perspective (Galán-Muros and Davey, 2017) to develop new models, based on the exchange of resources in an open environment, where actors are able to create value in a more efficient context of exchange. As Audretsch and Belitski (2021) highlight, to date, there is still too little research about this process. We propose linkages as a key factor of the university-industry ecosystem developing a theoretical proposal that explains its relevance, based on this SDL approach.

## 2.2 University actors and actor disposition

Although the engaged university is not a new name, its content is in a continuous process of evolution as it adapts to the new challenges that the open context offers to universities and they work to develop their active role in the society in which they are embedded (Breznitz and Feldman, 2012; Clauss *et al.*, 2018; Kliewe *et al.*, 2019; Longva, 2021). Universities occupy a strategic position in society, as a hub for connecting and managing heterogeneous actors. In this context, actors' resources and their desire to connect result on effects on the university itself and the society.

The role of actors in the university context demands a specific analysis and definition. SDL theory (Vargo and Lusch, 2017, p. 8) posits in its fundamental premise number nine (FP9) that "all social and economic actors are resource integrators" and FP6 refers to how resources become value for the actors involved in the transaction by stating that "value is co-created by multiple actors". Regarding this process of value co-creation, Storbacka *et al.* (2016) consider AE to be a microfoundation for value co-creation and propose the concept "actor disposition" to bridge the process from theory to practice: "actor disposition is defined as a capacity of an actor to appropriate, reproduce or, potentially innovate upon connections in the current time and place in response to a specific past and/or toward a specific future" (p. 3012). In line with this perspective, Brodie *et al.* (2019) define AE as "a dynamic and iterative process that reflects actor dispositions to invest resources in their interactions with other connected actors in a service ecosystem" (p. 2). Adopting this perspective, we consider that engagement manifests through actor engagement behaviors, whereby market actors influence each

other's dispositions and behaviors (Alexander *et al.*, 2018; Fehrer *et al.*, 2020). So, we aim at exploring how to increase resource density through the linkages between actors as a strategic step to facilitate and expand resources (Nenonen and Storbacka, 2018).

Based on the RQ1 proposed: What is the role of UIL in relation to actor disposition and resource density in university–industry ecosystems? And building on theory, we formulate the first research proposition.

*P1.* Linkages have a direct influence on actor disposition in the university–industry context.

### 2.3 Resource density

Increasing resource density in an open and increasingly collaborative context constitutes a challenge for markets in general (Fehrer *et al.*, 2020; Shi and Shi, 2022) and universities in particular, as it represents a radical change of strategy in an increasingly collaborative context (Baker *et al.*, 2021). If, in the past, the value resided in increasing the university's individual volume of resources, now the value measurement must consider digitalization and other new processes that liquefy and expand the scope of resources (Amit and Han, 2017; Lusch *et al.*, 2010; Nenonen and Storbacka, 2018). Bingham and Eisenhardt (2008) were pioneers in considering linkages among resources as a core strategic logic regarding competitive advantage and, in this sense, affirm that “the source for competitive advantage lies in the linkages among resources, not just with their attributes” (p. 254). This perspective has become more pressing in the growing collaborative economy in which universities are embedded. Storbacka (2019) highlights with clear perspective that now “although it is easier and cheaper to access resources, resource density needs to be evaluated in relation to actor goals” (p. 6). In this context, universities are in need of planning connectivity among engaged actors' resources, as it represents a cornerstone that is required in order to reach a competitive position.

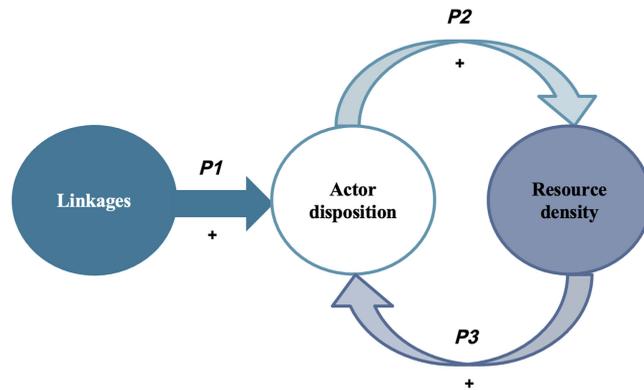
There are two key concepts related to management of resources from the SDL ecosystem perspective: integration and interaction (Löbler, 2013; Peters *et al.*, 2014). Peters (2016) makes an interesting distinction considering two different ways to combine resources: *homopathic* – a simple summative or aggregative effect, in which “the resultant effects are identical to the sum of the effects of each of the base resources acting in isolation” – and *heteropathic*, with “the presence of emergent properties [that] are new and novel (i.e. have not occurred before) and unpredictable” (p. 3003). We will build on these concepts when evaluating the character of the linkages designed in order to improve resource density in universities. Fehrer *et al.* (2020), make a theoretical and empirical contribution to the design of strategies to improve density in the markets, considering this topic as a new research area. Their contribution makes an innovative categorization of three lines of action to manage in order to improve resource density: (1) Decoupling existing resource linkages in market systems, (2) Creating new resource linkages in the market systems and (3) Stabilizing resource linkages in the market systems. This approach is very interesting, as it takes an innovative vision to the confluence of actors as a source, not only for resource generation but also for innovation in ecosystems.

The literature review connecting actor disposition with resource density leads to the formulation of the second and third research propositions:

*P2.* Actor disposition has a direct and positive influence on resource density in the ecosystem.

*P3.* Resource density in the ecosystem has a direct and positive effect on actor disposition.

Figure 1 jointly depicts the relations presented by the three propositions.



Source(s): Author's own creation work

**Figure 1.**  
The influence of UIL on actor disposition and resource density

#### 2.4 University–industry linkages (UIL) and resource density

The UIL concept has a long tradition in academic entrepreneurial and higher education literature. Defined as “bi-directional linkages between university and industry entities established to enable the diffusion of creativity, ideas, skills and people with the aim of creating mutual value over time” (Plewa *et al.*, 2013, p. 23), there has been extensive research attention upon UIL. In our conceptualization from the SDL and AE perspectives to improve the understanding of the role of UIL in the development of resource density, the approach developed by Plewa *et al.* (2013, 2019) adopting a stakeholder focus is of special interest. The works of Guerrero and Urbano (2012), Neumeier and Santos (2018), Polese *et al.* (2021), Quero *et al.* (2022) and Theodoraki *et al.* (2017) are also significant for their systemic and network conceptualization of university–ecosystem, that breaks with the traditional dyad (university–industry) linkage to incorporate “collaborative interactions” that resonate with the perspective of engaged actors’ disposition, capable, not only to sum up, but to change the university context.

Building on the contributions discussed above on engaged actors and resource density in the university–industry ecosystem, the present paper brings to the fore the need for a re-conceptualization of UIL, integrating the new context and interactions that universities are facing. So, framed on the SDL and AE theory we can define UIL as “connections among actors in the university sphere that result in resource integration or interaction”. Importantly, this definition adds a strategic dimension to linkages that has to be taken into account when adopting an ecosystem approach to the university.

### 3. Method

The novelty and complexity of the topic under research required in-depth information and led to the design of a qualitative research. Specifically, we developed a four-case study approach that, according to qualitative literature, is the most appropriate approach to find new ideas that can be interpreted from the theory and enables theory-building with higher-quality in-depth information (Eisenhardt, 1989; Gioia, 2021; Gummesson, 2017). According to Yin (1984, p. 14) this methodology “contribute uniquely to our knowledge of individual, organizational, social, and political phenomena”. Also, Feagin *et al.* (1991) highlight among its benefits its suitability as a strategy to collect information of the social reality, including the relations (interchange of resources) between individuals or groups. In this sense, even a single case study which typically presents an in-depth analysis of a societal unit is an appropriate

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methodology to examine a service ecosystem (Aal *et al.*, 2016; Baron *et al.*, 2018; Edvardson *et al.*, 2014; Nenonen *et al.*, 2019). In the present research, we focus specifically on the university–industry connection, as it represents specific qualities that require the combination of both a theoretical and an empirical approach. As Brodie *et al.* (2017), Kholi (2017) and Nenonen *et al.* (2017) propose, there is a need to theorize with managers to bridge the theory–praxis gap; in particular, as is the case of linkages and resource density, when the topic is new and under-explored and aims at having not only theoretical but practical effects in the university management context.

### 3.1 Case selection and data collection

With the aim of answering the RQ1 posted we analyzed international successful cases of university initiatives that have fostered the connection between actors, their exchange of resources and co-creation performance, contributing and boosting their university–industry ecosystem, i.e. successful UIL. The in-depth analysis of those UIL permits the development of the uRD management model, that takes into account both actor disposition and resource density. For the case selection and data collection we combined primary and secondary data sources within three phases.

In a first phase, to select the cases of study, we reviewed international university rankings, as well as scholarly journal publications on the topic of university–industry ecosystem, and we identified four successful cases that fit the objective of the research (Columbia Lab-to-Market Accelerator Network, Oxford University Innovation, Auckland Uniservices and the Münster Center for Interdisciplinarity). Those initiatives are benchmarks in their respective countries (the USA, New Zealand, the UK and Germany) in relation to technology transfer and the promotion of university–industry relations and known as top world universities in terms of university–business ecosystems. In this regard, we considered it relevant that the sample was international, since the common conclusions from different realities provide validity to the study. In the process of selecting the case studies data were triangulated with multiple sources to increase robustness and quality (Yin, 1984). We cross-checked the secondary data found to confirm the international leading role of the four universities participating in the qualitative analysis.

All the universities have top positions in international and national rankings and/or have shown excellent performance in promoting interconnected university–industry ecosystems; e.g.: University of Columbia: eighth in Best Global Universities 2022-Shanghai Ranking, 16th in US College Ranking 2022, 12th in World Reputation Rankings 2021; Oxford University: best university in the world for seventh consecutive year by THE Ranking 2022; seventh in Best Global Universities 2022-Shanghai Ranking, first in the Research Excellence Framework of UK (REF) 2022, which highlight the effectiveness of research transfer by making critical contribution to society; University of Auckland: sixth in University Impact Ranking and the 24th university in the world with more impact specifically on Industry and Innovation (THE Impact ranking 2022), first university of New Zealand in QS World University Ranking 2022; Münster University of Applied Science: known for its practical orientation it has a great impact in the innovation of the country, the university is leading in connecting boundaries between disciplines to foster university impact, awarded as one of the Top five universities in Germany applying the best strategies of university–industry knowledge exchange and tech transfer, also European good practice recognition in university-business cooperation. Appendix 1 contains more information on the sources that led to the case selection.

In a second phase, in-depth qualitative information was required in order to understand the complex process that underlies university–industry ecosystems. Primary data were collected through four semi-structured interviews in which, based on previous established leading questions or topics, the interviewee had the opportunity to discuss the topics under

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research freely. We organized the interviews around general issues or topics which facilitated a good development of the interview process, following the recommendations of [Stake \(2005\)](#). [Appendix 2](#) contains the main topics that served as a guide for conducting the interviews. In terms of timing, the interviews were made between January and July 2021. They were developed online and recorded using Zoom. We collected data until theoretical saturation was reached and we could observe no new information emerged. The period of time of the data collection allowed for observing how the main trends in the resulting information became redundant and the interviews were no longer yielding new insights. At this point we considered the process of collecting primary data to be complete. We coded the cases successively from 1 to 4: Columbia Lab-to-Market Accelerator Network: Int-1, Oxford University Innovation: Int-2, Auckland Uniservices: Int-3 and the Münster Center for Interdisciplinarity: Int-4.

The third phase of the data collection consisted on a triangulation of this primary data, gathered through the interviews, with secondary online data (websites of the specific initiatives and programs commented during the interviews, publicly available communication material, publications in social media, etc.) in order to contrast and confirm the information gathered and increase the robustness and quality of the study ([Yin, 1984](#)). This secondary data also helped to understand the context of each case study.

[Appendix 1](#) summarizes the main information regarding the case selection and codes, the university organization collaborating in the research and the expert profile representing it. The main secondary sources that led to the selection of the specific case and justify its inclusion in the study (first phase) and the sources that were used to contrast the information collected during the interview (third phase) are also presented in the table.

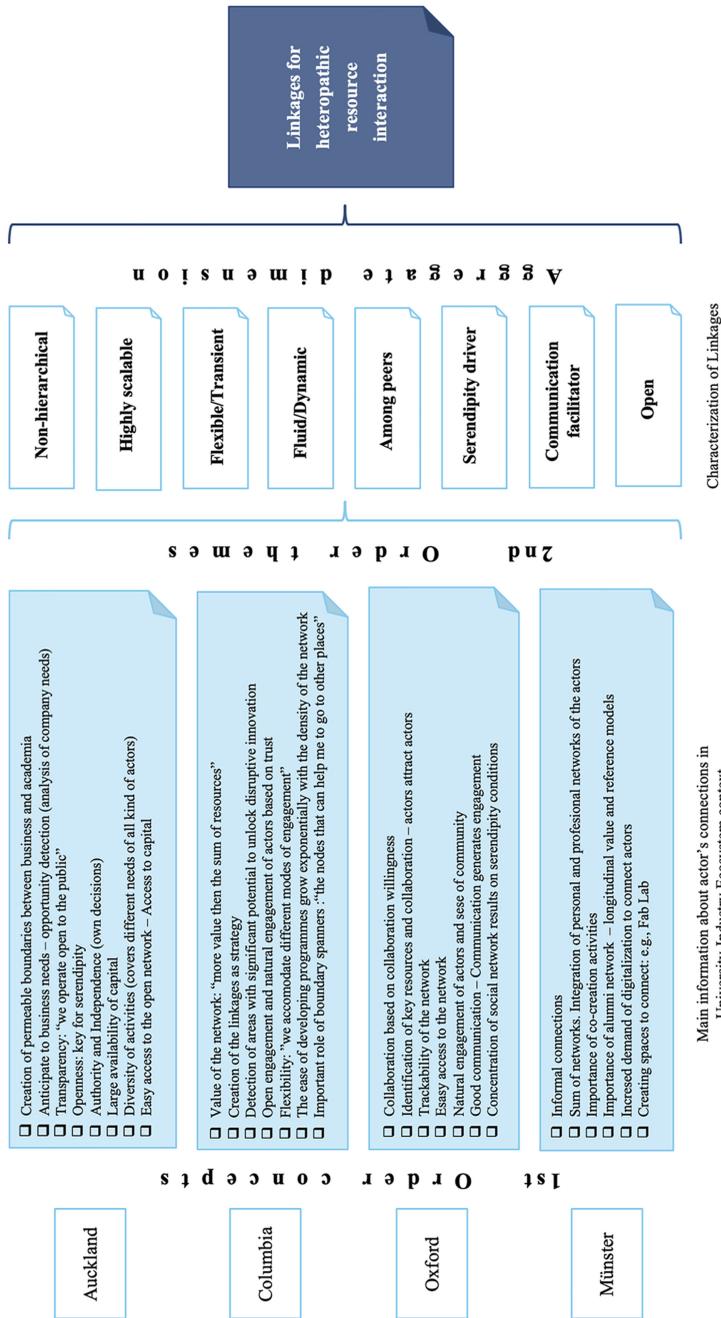
#### 4. Analysis and results

We analyzed our data using open axial selective coding ([Scott and Howell, 2008](#)). With the aim of shaping UIL characteristics, following [Gioia et al. \(2013\)](#) and [Gioia \(2021\)](#), we open-coded the data manually in order to be able to discern useful content for the research. The open data coding process relied on thematic analysis that takes “raw data and raises it to a conceptual level” ([Gummesson, 2017, p. 205](#)). In the process of understanding the central phenomenon and its patterns we identified three categories of concepts. The data structure from the analysis is presented in [Figure 2](#).

The first order concepts contained raw information regarding actors' disposition, connections and exchange of resources that were selected from primary data. We conducted this first step analyzing the transcript made of each interview. The second order analysis, that is “firmly in the theoretical realm, asking whether the emerging themes suggest concepts that might help us describe and explain the phenomena we are observing” ([Gioia et al., 2013, p. 20](#)), resulted in eight second order concepts. At this stage, we were able to connect theoretical approaches toward linkage characterization in the university–industry context with the data obtained in the first order concepts. Thus, we identified eight UIL characteristics. The third and last step drove us to distill the second order themes into one aggregate dimension: linkages for heteropathic resource integration.

Direct exchange of information with managers from case studies helped us in connecting data from first to second order and also to improve knowledge about specific information emerging from the secondary data analysis. All the researchers participated in the coding, to provide greater robustness to the concepts extracted from the case studies. The findings yield by the data structure has been discussed among the researchers and also presented at an international workshop to seek external feedback (Seventh Naples Forum on Service –2021).

Based on the data structure resulting from the open axial coding and the in-depth analysis of the interviews, the relationships identified between the three key concepts of this study are



Main information about actor's connections in University-Industry Ecosystem context

Source(s): Author's own creation work

Figure 2. Data structure

presented below: UIL, actor disposition and resource density. The results follow the structure of the three formulated propositions and conclude in the definition of a resource density management model for universities in the context of the university–industry ecosystem (the uRD management model).

*4.1 The positive and direct influence of linkages on actor disposition*

The four cases in the research all have a very clear notion of being an ecosystem and developing their activity in a network. The transcription of texts allowed us to identify positive connections between UIL and actor dispositions. In the four cases, there is clear evidence of how linkages were seen as very important in order to engage actors. For example, in In-3, it is stated that there is a need to “... *speak more than one language, we can speak the language of business and we can speak the language of academic research. That has the effect of creating a permeable boundary between the university and the outside parties we engage with*”. According to this perspective, we can find on In-2 that is relevant “*having people with good networks (. . .), thinking how do we get them into Oxford, how do we get them to work together . . . You let the engagement generate organically from that*. In the same line, the expert on In-2 comments: “*It should be a mutual willingness to be part of this (. . .) It is “Open Engagement” focused on specific goals that we establish at the outset*”. Thus, the collected data highlights the importance of UIL in the network to improve the capacity of an actor to co-create value (appropriate, reproduce or innovate) upon connections (actor disposition). **Table 1** contains the most representative in this relation.

*4.2 The positive and direct influence of actor disposition on resource density and vice versa*

As described in the theoretical framework, literature connects increased actor disposition with higher levels of resource density in contexts other than universities, because incremented actor disposition to engage would result in a higher quantity of resources

Interview	Quotations
In-1	“They <u>engage naturally</u> when they feel the trust in the network” “ <u>Digitalization</u> has played a tremendous role in continuing our ability to deliver value (ex. collaborative software, meetings . . .), to permit the continuity of the programs and relations”
In-2	“I think engagement happens quite <u>naturally</u> , because when you want to bring in a certain resource (e.g. investors), people that are already in the network and have contacts with investors will help you with that. It all comes down to having <u>good resources</u> and <u>communication</u> and <u>marketing</u> (. . .) Communicating what we are doing is essential for the engagement of the actors, to get more actors and activities and enhance the ongoing ones” “They collaborate with us based just on collaboration willingness or needs or by the recognition they get to do things with Oxford”
In-3	“Other universities we work with they focus more on the researcher, what they wish to do and pushing it out to the world. In Auckland some of the researchers are oriented that way but many more work in another way: Let’s find a match between an interesting problem, an interesting kind of expertise, where something can be done. It is to <u>think about</u> not just the research but also the translation of <u>that research to impact</u> in some way” “We have very engaged actors from the business and academic side, the <u>access</u> to our services is easy”
In-4	“ <u>Digitalization</u> facilitates the participation of companies in various activities in collaboration with the university (. . .) more availability of resources (. . .) we reach much more people” “The students engage because of the <u>incentives</u> they get (ECTS, money, a bridge to the Company, a certificate . . .)”
<b>Source(s):</b> Author’s own creation work	

**Table 1.**  
Quotations connecting  
UIL and actor  
disposition

exchanged by all the actors in the network. Table 2 contains references to this connection. A very clear evidence of this relation is presented by the expert of In-3, who posits “*The density is created in the institution but also by the actors through their interactions*”. In the same line, In-4 make an explicit reference to the role of linking personal and professional contacts to strengthen the dimensions of the ecosystem and, in due course, the resource density: “*We didn’t start from zero, we have a transfer center at the university with previous relationships with companies and also strong relationship with economic development institutions (intermediates) that give advice. We started from a strong ecosystem and from past relations with companies, both personal and professional contacts*”. In each of the cases, there is an underlying idea of the bi-directional relationship between the volume of actors’ disposition to engage and the density of the ecosystem. In-2 also captures this idea explicitly: “*The concentration of innovation fosters the concentration of the social network*”.

#### 4.3 Characteristics of linkages in high-density resource university–industry ecosystems

The second part of the research shed light on those characteristics of linkages that make possible the management of the resources based on the heteropathic resource interaction (as opposed to aggregation or summation). Building on the philosophical nomenclature brought to the management sphere by Peters (2016), we aim at discovering those linkages that make possible an ecosystemic exchange of resources based on multiplicative interactions between actors. Following Gioia et al. (2013), as presented in Figure 1, we are able to identify eight second order concepts that represent characteristics of UIL that foster heteropathic resource interaction. Table 3 contains a brief description of those characteristics that arose in common from the information obtained in the analysis of the case studies: Non-hierarchical, highly scalable, flexible/transient, fluid/dynamic, among peers, serendipity driver, communication facilitator and open.

Interview	Quotations
In-1	<p>“The growth of the network is a more meaningful growth; we are able to engage with partners more easily because we already can <u>lean on existing relationships</u>”</p> <p>“The most valuable people in the network for us are people in a similar position as we are (. . .) The person, within a company or within another university, who gets what I am trying to do and provides me with the relationships I need to develop a specific idea or program (. . .) The nodes that can help me to go to other places”</p>
In-2	<p>“The <u>sense of community</u> fosters the engagement of the people once they get in, to attract more people (increasing the density of the network)”</p> <p>“If we are talking about Oxford, not just as the University, but as the cluster, you gonna have people coming in with an academic role, an entrepreneurship role, and investor role . . . and they all have their <u>links beforehand</u> so we will have them in the ecosystem too, and they come from their <u>experience beforehand</u>. But once they are in the network the ecosystem will help them to open up more doors (going back to the idea of the brand recognition of Oxford). So once you get here you already have your network but you find it much easier to build up your network even more.”</p> <p>“We are always trying to bring more <u>talent</u> and resources into Oxford. So once they get here and are part of everything we are doing, then we add their networks to our networks and then they can expand their networks but it’s part of our overall network”</p>
In-3	<p>“<u>Activity</u> generates activity”</p>
In-4	<p>“All the colleges from the University of Applied Science had jobs in companies before (<u>beforehand business experience</u>). So they brought the personal contacts to the initiatives at the university. Those personal contacts are the base for cooperating with companies”</p>

Source(s): Author’s own creation work

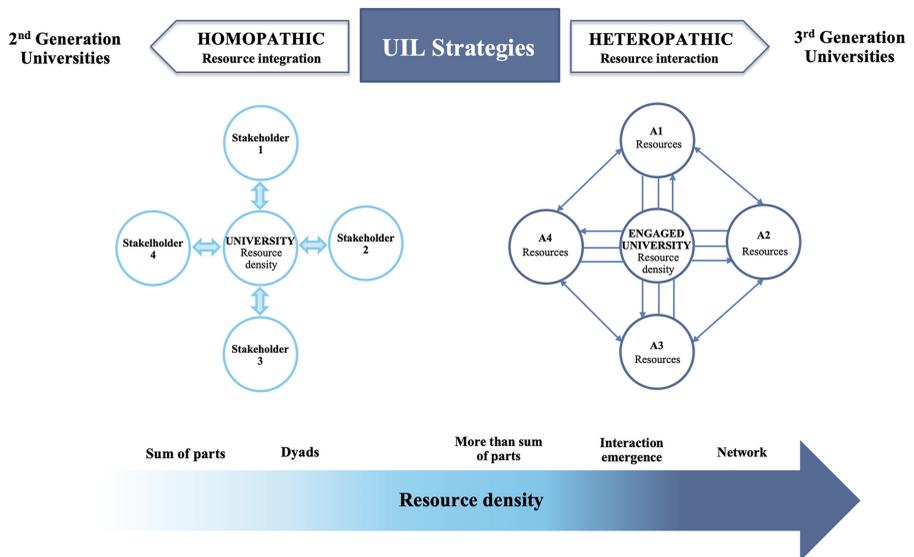
**Table 2.** Quotations connecting actors’ disposition and resource density

Characteristic	Meaning according to primary data
Non-hierarchical	Any actor can make contributions to other actors, exchange information, etc.
Highly scalable	High adaptation to the needs of the actors
Flexible/Transient	Flexible commitments among actors – opposite to long-lasting relationships Network relationships relate to each other to solve a problem and finish or change into another context/project Relations are flexible but can be longlasting
Fluid/Dynamic	UBC activities with long term focus They are in continuous transformation
Among peers	No matter what the role of the actors is, there is a high degree of freedom on the exchange of resources (ideas, money, etc.)
Serendipity driver	Ideas emerge among actors in a free way that enables innovations to arise through their convergence Foster serendipity through innovation and resource density
Communication facilitator	Speak more than one language to generate successful connections. Creation of permeable boundaries between business and academia
Open	Ease of access to and transparent transactions/activities Speed to act and change direction Delegate/externalize, engage actors in different activities

**Source(s):** Author's own creation work

**Table 3.**  
Characteristics of hetheropathic UIL

Based on the characteristics identified through the qualitative analysis and the theoretical SDL and AE approaches, we establish management strategies to increase actor disposition and, in turn, resource density in the university–industry ecosystem. Those strategies are presented in the uRD management model (Figure 3), that explain how the resource density can be increased through different UIL management strategies, from homopathic resource integration to heteropathic resource interaction.



**Figure 3.**  
uRD management model. Homopathic VS Heteropathic strategies

**Source(s):** Author's own creation work

The first management strategy, *homopathic resource integration*, is characteristic of second-generation universities, which base their relations on dyadic exchange of resources or transactions. In this case, the actor disposition lead to an interchange of resources with a summative effect, i.e. the resulting resource density is the sum of the parts transacted. The opposite management strategy is the exchange of resources in an heteropathic manner, *heteropathic resource interaction*. In this case, the result of the interaction of the actors generates a multiplicative effect on the resource density, which constitute more than the sum of the parts exchanged. This type of relations follows an ecosystemic approach and is typical of third-generation universities.

## 5. Conclusions

### 5.1 Theoretical implications

The present paper employs SDL and AE perspectives to explore how to increase resource density in the university–industry ecosystem. In this sense, [Fehrer et al. \(2020\)](#) highlight that “the process of increasing resource density and value creation in market systems deserves reflection and exploration” (p. 1434) and consider that understanding how to increase resource densities is a main research area. [Vargo et al. \(2023\)](#), highlight the need for research on emergence connected to actor’s interaction in a parallel path with [Granstrand and Holgersson \(2020, p. 3\)](#), who coined a new definition of “innovation ecosystem”, highlighting the need for research into networks of actors and their connections with artifacts and activities in an institutional context.

The theoretical contributions of the present paper connect to the demand for an explanation of how and why ecosystems connect actors to obtain a multiplicative result, enhancing the benefit for all of the actors in the network. We adopt [Peters’ \(2016\)](#) nomenclature to make a distinction between two alternative strategies for managing UIL.

- (1) *Homopathic strategy*: in which actors’ resources connect, with summative results. In this case, resources would accumulate. One example would be the traditional value-distribution chain. Every actor adds a specific value and obtains a predetermined and clear benefit from it. In the case of universities, resources increase (for example, the content of research) but there is non-open space for any unplanned value.
- (2) *Heteropathic strategy*: As a driver for management, the heteropathic strategy is framed on a new general theory of markets in which actors’ interactions result in multiplicative effects and knowledge spillovers ([Akaka et al., 2021](#); [Pels et al., 2022](#); [Plata et al., 2021](#); [Vargo et al., 2023](#)).

In this context, the present paper offers new insights regarding the qualities that characterize linkages in ecosystems to improve actor disposition and resource density, increasing both the value of the network and the actor commitment to the network, in a recursive process. Thus, answering the [RQ1](#) posed in the study, UIL among actors arise as a strategic factor, capable of maximizing their disposition to engage and, as a result, to improve resource density, which ends in a recursive loop: the greater the increased resource density, the higher the actor disposition, and the reverse. According to this perspective, further research on UIL management is of great interest and, probably, even the adaptation of this approach to other ecosystemic contexts.

The academic research inside and outside the higher education environment is clearly concerned with the benefits of management adopting an ecosystem perspective ([Bealieu et al., 2019](#); [Howells et al., 2012](#); [Pels et al., 2022](#); [Scott et al., 2022](#)) and, importantly, how the same ecosystem, with its self-adjusting quality, can be encouraged to bring about innovation through the work of its actors ([Fehrer et al., 2020](#); [Vargo and Lusch, 2016](#); [Vargo et al., 2023](#)). In

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this context, new systemic approaches arise, calling for the need for developing research related to “innovation ecosystem performance” (Plata *et al.*, 2021, p. 137).

On a parallel path, the university, on the knowledge and technology transfer mission inherent to its existence, is facing the same challenges and the same need for models that improve its open challenging environment, as recent research has explicitly demanded (ODwyer *et al.*, 2022; Polese *et al.*, 2021; Radko *et al.*, 2022).

The role of UIL and their influence on actor disposition and resource density represents one step in this process, and thus sheds light on part of the process to improve the understanding of ecosystems and how network behavior is connected. Plata *et al.* (2021), adopting an institutional perspective, make an explicit demand and consider “urgent” the need for research in this context. In the same vein, Shi and Shi (2022) call for research “explaining how entrepreneurial ecosystems may sustain their competitiveness over time” (p. 13).

The research propositions that configure the startpoint of the theoretical model of the present paper represent one step ahead in this area of research, offering three paths to shed light on this arena:

P1. Linkages have a direct influence on actor disposition in the university–industry context.

P2. Actor disposition has a direct and positive influence on resource density in the ecosystem.

P3. Resource density in the ecosystem has a direct and positive effect on actor disposition.

These propositions represent a theoretical discussion, that might be addressed in future research: whether linkages should be contemplated as a specific element (to be considered and managed by itself). Indirectly, recent new definitions of entrepreneurial innovation ecosystems include networks as “the connectedness of business for new value creation” (Stam and Van de Ven, 2022, p. 181). Grandstrand and Holgersson (2020) also make an explicit reference to the connections among ecosystems elements. We propose that UIL should be added as an element of the ecosystem by itself, as previous literature on ecosystems (i.e. Tronvoll, 2017) already considered the need for giving linkages such recognition. Specially, in the university–industry context, linkages represent a strategic role fostering engagement, actor disposition and resource density.

These propositions also open future discussion regarding how the management of UIL represent an institutional change. Plata *et al.* (2021, p. 147) highlight the need for research on the effects of “informal and formal institutions on the interactions of micro-level and macro-level representations with the emergence of entrepreneurial networks”, and Ventura *et al.* (2020) develop an analysis of linkages as a strategic factor to reach radical innovation in the university context and call for research in this field.

### 5.2 Managerial implications

The propositions and the uRD management model depict how organizations that have developed an ecosystem perspective, make a characteristic and strategic use of the UIL among the actors. This turns linkages a factor that requires a specific planning, with consequences on actor engagement and its effects on resource density.

The contextualization of the research in the university–industry ecosystem answers the call for research into UIL (Plewa *et al.*, 2013, 2019). We coin a new definition of UIL, adopting a SDL and AE approach, and propose the qualities that characterize third-generation universities in terms of UIL, with the aim of establishing strategies to maximize actor disposition and resource density. The three propositions in the research, design a path for

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working to be in line with this kind of universities. So, the proposed strategies, synthesized in [Figure 3](#), provide important practical contributions to university management:

- (1) *Homopathic resource integration*: improves resources summing up the volume of stakeholders. There is a dyadic perspective on each relationship, and there is no specific arena designed for stakeholder interaction: i.e. enterprises connect with the university in order to get specific resources like knowledge, students with particular competences or solutions to specific problems.
- (2) *Heteropathic resource interaction*: puts the focus on actors interaction, designing spaces where UIL are characterized by being non-hierarchical, highly scalable, transient, dynamic, among peers, serendipity driver, communication facilitator and open. This makes possible a higher level of engagement in the network, increasing resource density and facilitating emergence of new projects, ideas, etc. A good example would be the case studies under research: Columbia Lab-to-Market Accelerator Network, Oxford University Innovation, Auckland Uniservices and the Münster Center for Interdisciplinarity, as they account for an increasing number of actors that foster successful and sustainable relations with industry, building a strong ecosystem based on co-created value. In this line, the enhancement of UIL for heteropathic resource interaction should be promoted and managed by universities to foster the opportunities and willingness of actors to engage and, in turn, increase the density of available resources in university–industry ecosystems.

The system  
effects of  
linkages

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## 6. Limitations and future research

For the present paper we have had the opportunity to delve into four outstanding case studies representing top world universities regarding their university–industry ecosystems. Top managers, experts on knowledge and technology transfer and university–business relations, in charge of renewed university units that are key actors in their ecosystems and successfully foster entrepreneurial networks, have shared their experiences. This has represented significant opportunities to develop an in-depth understanding of this process. [Nenonen et al. \(2017\)](#) propose the combination of academic theory with the experience of managers in order to drive research toward useful theoretical and empirical results. The present paper demonstrates an innovative collaborative process between researchers and managers that enables theory to be developed, filling the theory–practice gap. This perspective has been strongly supported by [Gummeson \(2017\)](#), [Nenonen et al. \(2017\)](#) and [Kohli \(2017\)](#).

At the same time, case studies in the specific context of UIL have, as a first consequence, the limited generalizability of the findings. Nonetheless, the propositions that result from the research and the characteristics of UIL represent one step forward in improving knowledge regarding university–industry ecosystems and how to identify their much sought-after emergence, evolution and self-adjustments. Although the present paper focuses on UIL, future research will be needed in order to improve the knowledge on this topic. Three ideas arise as priorities: first, it would be interesting to see in which sense the principles that result from the present research can be applicable to other sectors different from the university context. Second, the acknowledgment of linkages as an element to be planned and designed in an innovation ecosystem (as proposed originally by [Tronvoll, 2017](#)), would be the starting point to improve the knowledge and categorization of this element. Literature refers to the importance of connections in entrepreneurial ecosystems (i.e. [Scott et al., 2022](#)), and as a basis to reach radical innovation ([Ventura et al., 2020](#)), but, nonetheless, more defined theoretical and empirical evidence is needed. Finally, this perspective of radical innovation rooted in

institutions is a growing trend that connects the present work with institutional theories (Vargo *et al.*, 2023) and with recent proposals for further research in this field (Aparicio *et al.*, 2016; Plata *et al.*, 2021; Scott *et al.*, 2022).

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## Appendix 1

The system effects of linkages

Code	Case	Data
In-1	Columbia Lab-to-Market Accelerator Network (University of Columbia)	<p><i>Primary data</i> Semistructured interview with Dmytro Pokhylko, Director of Columbia Lab-to-Market Accelerator Network</p> <p><i>Secondary data</i> Columbia Lab-to-Market Accelerator Network's website <a href="https://labtomarket.columbia.edu/content/about-l2m">https://labtomarket.columbia.edu/content/about-l2m</a> Position of the University of Columbia in global rankings: Times Higher Education Rankings: <a href="https://www.timeshighereducation.com/world-university-rankings/columbia-university">https://www.timeshighereducation.com/world-university-rankings/columbia-university</a> World's University with Real Impact 2022: <a href="https://www.wuri.world/2022-global-top-100">https://www.wuri.world/2022-global-top-100</a> QS: Top Universities 2023: <a href="https://www.topuniversities.com/university-rankings/world-university-rankings/2023">https://www.topuniversities.com/university-rankings/world-university-rankings/2023</a></p>
In-2	Oxford University Innovation (Oxford University)	<p><i>Primary data</i> Semistructured interview with Gregg Bayes-Brown, Media and Communications Manager of Oxford University Innovation</p> <p><i>Secondary data</i> Oxford University Innovation's website <a href="https://innovation.ox.ac.uk/">https://innovation.ox.ac.uk/</a> Shanghai Ranking: <a href="https://www.shanghairanking.com/institution/university-of-oxford">https://www.shanghairanking.com/institution/university-of-oxford</a> Times Higher Education Rankings <a href="https://www.timeshighereducation.com/world-university-rankings/university-oxford">https://www.timeshighereducation.com/world-university-rankings/university-oxford</a> Conlon <i>et al.</i> (2021). <i>The economic impact of the University of Oxford Report</i>. London Economics Heles (2020). "Oxford's ecosystem leads the way", Global University Venturing, apr. 2022. <a href="https://globalventuring.com/university/oxfords-ecosystem-leads-the-way/">https://globalventuring.com/university/oxfords-ecosystem-leads-the-way/</a> The University of Oxford Innovation Fund: <a href="https://parkwalkadvisors.com/fund/university-of-oxford-innovation-funds/">https://parkwalkadvisors.com/fund/university-of-oxford-innovation-funds/</a> Research Excellence Framework (REF): <a href="https://www.ox.ac.uk/research/recognition/REF2021">https://www.ox.ac.uk/research/recognition/REF2021</a> Most Innovative Universities of the world 2019-Reuters: <a href="https://www.reuters.com/innovative-universities-2019">https://www.reuters.com/innovative-universities-2019</a> World's University with real impact 2022: <a href="https://www.wuri.world/2022-global-top-100">https://www.wuri.world/2022-global-top-100</a> World's Top 50 University regarding Industrial Application 2022: <a href="https://www.wuri.world/2022-top-50-industrial-application">https://www.wuri.world/2022-top-50-industrial-application</a></p>

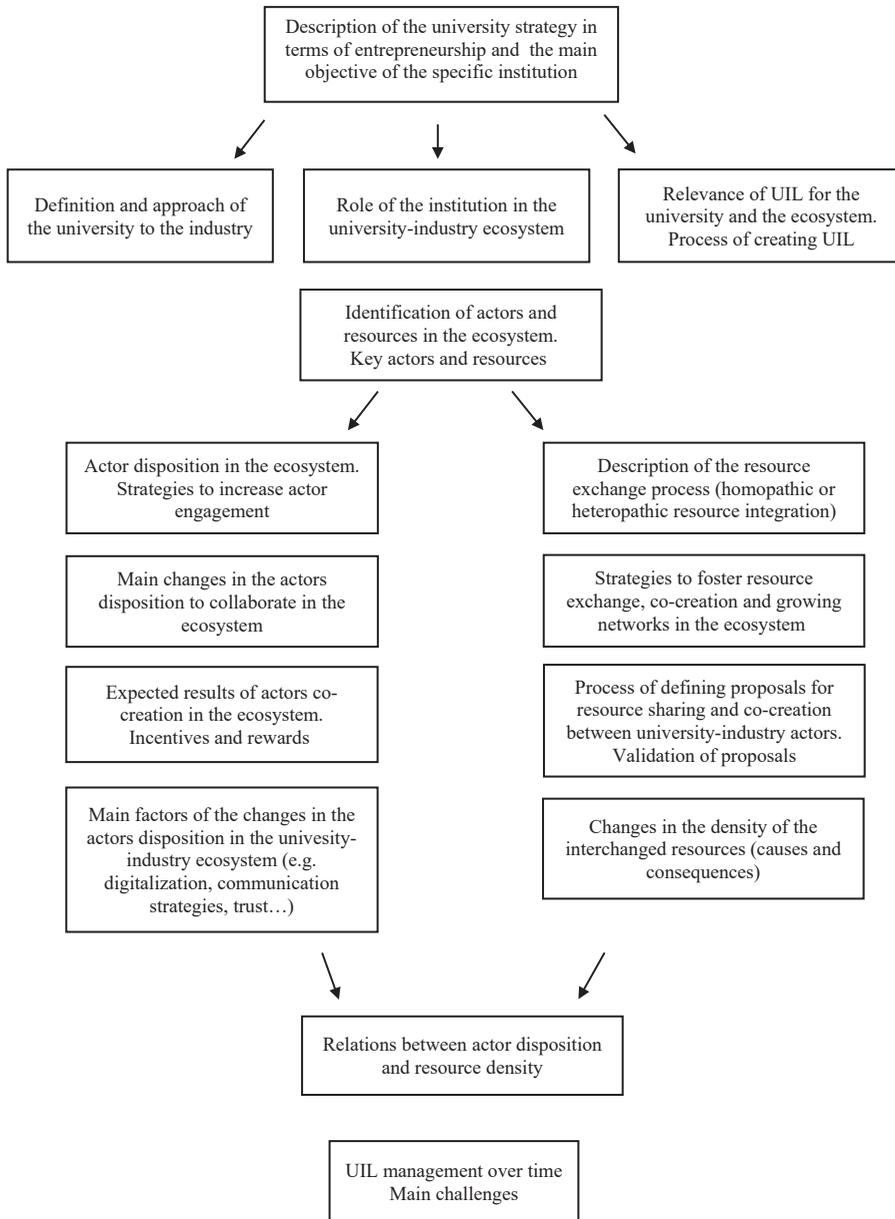
(continued)

**Table A1.**  
Case selection

Code	Case	Data
In-3	Auckland Uniservices (Auckland University)	<p><i>Primary data</i> Semistructured interview with Andy Shenk, Director of Auckland Uniservices</p> <p><i>Secondary data</i> <a href="https://www.uniservices.co.nz/">https://www.uniservices.co.nz/</a> Times Higher Education Ranking 2022: <a href="https://www.timeshighereducation.com/rankings/impact/2022/overall">https://www.timeshighereducation.com/rankings/impact/2022/overall</a> THE Impact Ranking for Industry, Innovation and infrastructure 2022: <a href="https://www.timeshighereducation.com/rankings/impact/2022/industry-innovation-and-infrastructure#!/page/0/length/-1/sort_by/rank/sort_order/asc/cols/stats">https://www.timeshighereducation.com/rankings/impact/2022/industry-innovation-and-infrastructure#!/page/0/length/-1/sort_by/rank/sort_order/asc/cols/stats</a> Auckland University rankings: <a href="https://www.auckland.ac.nz/en/about-us/about-the-university/our-ranking-and-reputation/New-Zealands-world-ranked-University.html">https://www.auckland.ac.nz/en/about-us/about-the-university/our-ranking-and-reputation/New-Zealands-world-ranked-University.html</a> Auckland investment and partnering: <a href="https://www.uniservices.co.nz/Investment-and-partnering">https://www.uniservices.co.nz/Investment-and-partnering</a> Uniservices Strategic Plan 2021–2025. University of Auckland</p>
In-4	Münster Center for Interdisciplinarity (Münster University of Applied Sciences)	<p><i>Primary data</i> Semistructured interview with Markus G. Schwering, Director of Münster Center for Interdisciplinarity</p> <p><i>Secondary data</i> <a href="https://en.fh-muenster.de/hochschule/organisation/mci.php">https://en.fh-muenster.de/hochschule/organisation/mci.php</a> <a href="https://www.fh-muenster.de/hochschule/organisation/mci.php">https://www.fh-muenster.de/hochschule/organisation/mci.php</a> Münster University of Applied Sciences Rankings: <a href="https://edurank.org/uni/munster-university-of-applied-sciences/rankings/">https://edurank.org/uni/munster-university-of-applied-sciences/rankings/</a> University Development Plan 2021–2015: <a href="https://en.fh-muenster.de/hochschule/downloads/hep-FH-Muenster-2021.pdf">https://en.fh-muenster.de/hochschule/downloads/hep-FH-Muenster-2021.pdf</a> Münster University of Applied Science: an entrepreneurial approach to working with business Smart.lab Münster University of Applied Science <a href="https://www.fh-muenster.de/smartlab/index.php">https://www.fh-muenster.de/smartlab/index.php</a></p>

Table A1.

Source(s): Author's own creation work



Source(s): Author's own creation work

**Figure A1.** Topics leading the semi-structured interviews conducted