Identifying contradictions in an incumbent–startup ecosystem–an activity theory approach

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Abstract

Purpose – Discussion regarding systems that promote innovation, aptly named innovation ecosystems, has been intensifying both in academia and business. The purpose of this paper is to introduce the activity theory as a theoretical framework for conceptualising and studying innovation ecosystems. Using the activity theory, it investigates elements that affect the success and viability of innovation ecosystems formed between startups and incumbent firms, collaborating with an established firm within the context of an open innovation programme.

Design/methodology/approach – This study uses an exploratory case research approach and proposes the activity theory as a theoretical background to be used in innovation ecosystem research. Based on this approach, this study draws from interviews and research observations in an innovation ecosystem formed between an established firm and various startups that aim to co-develop innovative offerings.

Findings – By applying the activity theory tools, this study identifies several contradictions between interacting actors of this innovation ecosystem that can adversely affect the innovation process. Furthermore, it proposes the use of the activity theory as a fitting theoretical lens to study innovation ecosystems.

Originality/value – The novelty of this study is related to the focus on the incumbent–startup context for extending the innovation ecosystem literature. Using the activity theory as a viable methodological tool allows us to conceptualise firms as social constructs and hence pinpoint inner characteristics that can affect and shape their interactions and the broader ecosystem. This process is further enhanced by the use of primary data that give unique insights into the inner workings of innovation ecosystems by identifying underlying contradictions.

Keywords Innovation ecosystems, Entrepreneurship, Startups, Activity theory

Paper type Research paper

1. Introduction

The past 15 years have seen a lot of attention being given to ecosystems as a means to create value. Shifting attention from the "lonely innovator firm" and the "classical linear models of innovation" (Chapman and Corso, 2005) to the "collective nature of innovation" (Wang, 2013), the concept of an innovation ecosystem (IE) has drawn increased interest in business research and is gaining ground in practice (Pucci *et al.*, 2018). As the need for more complex and special value propositions is ever growing, firms often have to rely on their IE to develop their offering (Beliaeva *et al.*, 2019).

While the validity of the IE terminology has been the subject of some debate (Oh *et al.*, 2016; Ritala and Almpanopoulou, 2017), IEs offer a chance to observe and explore innovation at a higher-level bearing into consideration the interdependencies amongst various different firms and organisations (Ritala and Almpanopoulou, 2017; Thomas and Autio, 2019; Yaghmaie and Vanhaverbeke, 2019). In IEs, the whole system focuses on the introduction of a

new product, service or a new way to create value for customers by innovating on a business model level (Yaghmaie and Vanhaverbeke, 2019).

Even though recent years have seen a flurry of publication around the issue of IEs, the concept's broad adoption has resulted in conceptual ambiguity in what constitutes an IE (Suominen *et al.*, 2019). More specifically, scholars dealing with the IE concept have been pointing out the need for conceptual rigour (Pucci *et al.*, 2018; Granstrand and Holgersson, 2020). Furthermore, as the exact nature of an IE remains ambiguous, it is also hard to pinpoint factors that can render such an ecosystem successful sustainable or attracting for participants. As a result, while several strategies for navigating and gaining value from ecosystems have been proposed (Hannah and Eisenhardt, 2018), committing to a new ecosystem is still regarded as a high-risk endeavour (Dattée *et al.*, 2018). Lastly, even though IEs have been identified as very important for new entrepreneurial ventures (i.e. startups), most scholars have mainly focused on large or multinational corporations and were less focused on startup small and medium-sized enterprises (SMEs) or other types of actors (Yaghmaie and Vanhaverbeke, 2019).

As IEs are an inherently multidisciplinary subject, this work proposes that to complete the picture, an interdisciplinary approach is required that involves tools and methodologies from other fields as well. More specifically, given the importance of social interactions within an IE and the effect that different cultures, organisational structures and personal goals have in the outcome of the innovation process within an ecosystem (Torres and Augusto, 2019; Pucci *et al.*, 2018), we propose the use of the activity theory (AT) as a tool to conceptualise IEs and identify critical factors for their success.

In this context, AT, and especially the notion interrelated or networked activity systems (Engeström, 2001; Spinuzzi, 2015), appears to be a promising theoretical framework, as it is often used to describe actions in a socio-technical system (Engeström, 1987). The AT rejects the isolated individuals as an insufficient unit of analysis, analysing the cultural and technical aspects of human actions (Bertelsen and Bødker, 2003). As such, it is regarded as particularly valuable to conceptualise complex real-world situations "where people, culture, and technology [. . .] meet and interact to catalyse creativity" (Carayannis and Cambel, 2009, p. 202). Parallelly, the primary aim of an IE is to support collaborative activities to jointly develop a technological innovation, thus framing the AT as a potentially relevant framework, as it places "the user and the user's activities in context, rather than placing the system itself at the center of the process" (Hasan and Banna, 2012, p. 2).

The AT also uses the concept of contradictions as a means of understanding and change (Ilyenkov, 1974; Engeström, 2001). Engeström and Sannino (2011) identify dilemmas, (critical) conflicts and double binds as important types of discursive manifestations of contradictions. These elements are also important elements for the success and sustainability of entrepreneurial ventures (Chen *et al.*, 2017; Diakanastasi *et al.*, 2018). This is also the case when we go to a higher level of analysis and observe the IE as a whole. In the case of IEs, actors are called forth to effectively manage conflicting cultural mindsets, roles and organisational goals (Nambisan and Baron, 2013). As such, the concept of contradictions can help further our understanding and map elements that can have an important impact on the innovation outcome of entrepreneurial ventures within an IE.

Considering the aforementioned research needs and the potential that the AT can bring into IE research, this work aims to answer the following research questions:

How can an IE be conceptualised using the AT?

What are the contradictions in an IE where incumbent firms directly cooperate with startups to co-develop a technological innovation?

To address these objectives and given the current level of research in IEs, this paper adopts an exploratory action research approach aimed at theory building, as it is suitable for research in areas where theory is not yet well developed, as is the case with the conceptualisation of IEs. Given such direction, primary data are undertaken that cover an incumbent firm and three different startups within a case study. An in-depth analysis of the workings of such expanded collaboration and the contradictions through the innovation process was performed using the AT as a theoretical framework.

This paper is structured as follows. Section 2 presents the interdisciplinary rationale behind our approach and provides background information on the IEs and AT. Section 3 presents the research methodology and the case explored. Section 4 provides our results in the conceptualisation of incumbent/startup collaboration as interacting activity systems and the identification of contradictions within such an IE. Section 5 provides the findings and discussion of the theoretical and practical implications, also including limitations and potential future work.

2. Related key concepts

IEs are an inherently complex subject affected by the entities existing within them on various levels. Companies operating within an IE can change its nature based on their organisational cultural and demographic qualities. Even more so, and especially when small firms (e.g. startups) are involved, social interactions and internal organisational issues can be of high importance to the performance of an IE.

The structure and interconnections within an IE can match it to what Newell (2001) defines as a "complex system" and as such can qualify for an interdisciplinary approach (Newell, 2001). Consequently, introducing tools and methodologies from other disciplines can illuminate issues and expose different angles (Razzaq et al., 2013). Interdisciplinarity is highly focused "on problems that need to be solved or on opportunities to be discovered" (Klein and Newell, 1998, pp. 393–394). From that angle, the interdisciplinary integration allows the creation of valuable insights that may serve as key points of departure to understand or even solve significant sectoral problems and/or unveil otherwise concealed prospects. Particularly in terms of theory building, interdisciplinarity allows the researchers to experiment with conceptual loans, different approaches and "disciplinary transplants", creating their hypotheses. Given the previously discussed relevance of AT principles to IE research, this work aims to utilise AT's theoretical tools to first conceptualise a hub-based IE (Nambisan and Baron, 2013) and then identify contradictions with said IE based on the work of Engeström and Sannino (2011) on discursive manifestations.

To achieve this goal, this section will present some background on IEs and AT and demonstrate how they fit together in the context of the presented case.

2.1 Innovation ecosystems

IEs have become a prominent issue for discussion both in academia and business. The rise of open innovation (OI) practices, the success of the various innovation communities, combined with the rising complexity of business environments have shifted a lot of focus on how an IE can be formed and be successful. OI was coined by Chesbrough (2003) and has emerged as a general concept for various collaborative innovation activities emerging in this context.

At the same period, scholars studying innovation recognised the role of communities outside of the boundaries of firms in creating, shaping and disseminating technological and social innovations. While the dominant role of users in creating functionally novel innovations more than 30 years ago von Hippel (1988), the advent of open-source software communities has highlighted the important role of communities in the innovation

process. Community-based innovation by its nature takes place outside the boundaries of the firm, which fits Chesbrough's definition (2003) of OI. Thus, communities and their role in the innovation process both fit within and offer an opportunity to extend the firm-centric concept of OI developed by Chesbrough and his colleagues (Chesbrough, 2003, 2006; West and Lakhani, 2008).

All the above have given rise to the idea of IEs, a concept that has been gaining a lot of traction. Leaving aside the discussion of whether the term "ecosystem" is fitting, the term has been used extensively in recent years (Gomes *et al.*, 2018). An IE has interchangeably been described by many terms, such as innovation community (Wang, 2013), innovation cluster (Ferras-Hernandez and Nylund, 2018), entrepreneurial ecosystem, creation nets (Rubens *et al.*, 2011). Several definitions of an IE have been proposed, some going back almost 15 years (e.g. Adner, 2006), but most remain relatively abstract. In view of this plethora of definitions, this research adopts the term IE, as given by Granstrand and Holgersson (2020), p. 3) who describe it as:

> ...the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.
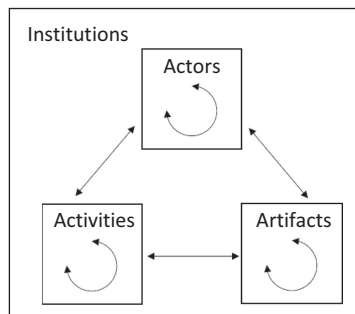
Granstrand and Holgersson (2020, p. 3) claim that an IE can incorporate "an actor system with collaborative and competitive relations with or without a focal firm, and an artefact system with complementary and substitute relations". This definition is also represented in Figure 1.

The characteristics of both the actors and the IE as a whole combined with the IE's de facto social structure makes the AT a promising framework to study IEs.

2.2 Activity theory and its connection to innovation ecosystems

The AT has its roots in Russian cultural-historical psychology. Vygotsky (1978) focussed on the study of situated, social interactions underpinning collective "human" activities (Kuutti, 1995; Hasan and Banna, 2012; Nardi, 1996). Thus, the human activity is coded and presented as a triangle with the subject, object and mediating artifact at each corner.

Since that time, the AT has expanded and changed to the point that current scholars are dealing with what is known as third-generation AT (Engeström, 1987). According to Engeström (2001, 2005), the third generation of the AT involves investigating collective, artefact-mediated and object-oriented activity in its network relations to other activity systems. Parallelly, IE research gives particular attention to diversity between different traditions and perspectives that exist within a system, a fact that further demonstrates AT's relevance to IE research.

Figure 1.
IE definition
visualisation
(Granstrand and
Holgersson, 2020)

Differences between the actors within an IE, and how these are managed, can variously affect the ecosystem's performance (Cobben and Rijakkers, 2018). Researching such factors can be challenging, but, to this end, this work proposes the use of contradictions – "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137) – offered by the AT. Contradictions are identified as disturbances, i.e. visible manifestations of contradictions (Capper and Williams, 2004; Murphy and Manzanares, 2008) or "unintentional deviations from the script which cause discoordinations in interaction" and "deviations in the observable flow of interaction" (Engeström et al., 1999, p. 91).

As such, we propose that contradictions can help explain the IE's inner workings, as they can help identify and conceptualise tensions derived from human activities. In any given activity system, contradictions can have different manifestations either within a component or between components or as a result of interactions between neighbouring activity systems (Yamagata- Lynch and Haudenschild, 2009). Engeström and Sannino (2011) claim that contradictions cannot be identified directly, but rather through such manifestations and pinpoint four types of discursive manifestations: dilemmas, conflicts, critical conflicts and double binds. Such manifestations can play an important role in the performance of entrepreneurial teams both internally (Jehn and Mannix, 2001) and externally (Nambisan and Baron, 2013). Consequently, identifying contradictions can help further our understanding and provide a more holistic view of IEs. Engeström et al. (1999) state that contradictions are "the motive force of change and development" (p. 9). This fact, coupled with their relevance to IE, can render the identification and resolution of contradictions an important driver for innovation.

2.3 Activity theory principles put in the context of an innovation ecosystem
As research around IEs is still growing, we propose that the AT offers a fitting set of tools and principles that can be used to offer a novel conceptualisation of IEs and study the relationships and social interaction between different actors that change the ecosystem's performance and sustainability.

Using the concepts and tools offered by the AT, this study specifically utilises the notion of interrelated or networked activity systems (Engeström, 2001; Spinuzzi, 2015) to construct and study an IE as a whole system. Shifting the focus of analysis from single activities to activity systems that work towards the co-development of an object is a process that has been argued to be of high importance (Engeström, 2001; Forsgen and Byström, 2017). Consequently, this element of broader systems formulated by smaller interconnected activities can be a promising match to an IE.

In these interrelated activity systems, we use the aforementioned manifestations of contradictions to identify the tensions between different actors.

3. Research method and context
To address the research objectives, the research design is based on an exploratory case research approach (Runeson and Höst, 2009) aimed at theory building (Eisenhardt and Graebner, 2007). Case research gained respect, as it brings the researcher in close proximity, both conceptually and physically, to the contexts of the underlying phenomenon, allowing for deeper engagement with the social settings (Fendt and Sachs, 2007). This type of research is particularly relevant, as it answers research questions that address "how" and "why" in unexplored research areas particularly well (Edmondson and McManus, 2007). As the purpose of this work is to propose a new theoretical background for IE research, a theoretical sampling of cases was deemed appropriate (Eisenhardt and Graebner, 2007). Theoretical

sampling means that cases are selected because they are particularly suitable for illuminating relationships and logic amongst constructs (Eisenhardt and Graebner, 2007). In theoretical sampling, single-case studies are common when a case is unusually revelatory, extreme exemplar or allow for unusual research access (Yin, 2009).

In this work, the single-case study theoretical sampling is adopted, as this particular case allowed researchers virtually unlimited access to the ecosystem workings, to company personnel, and the involved startups and incumbent where very open and willing to discuss both the positive and negative elements of the programme. Furthermore, this particular ecosystem existed before and after the data collection period, making an example of a sustainable IE and thus more valuable for research.

3.1 The context

Traditional research and development (R&D) models are no longer enough to correspond to modern needs; large companies struggle to incorporate an innovation culture and become more entrepreneurial. By contrast, it is much simpler for startups to embrace innovation and recalibrate traditional business models (Christensen, 2013). Technological innovations lie at the heart of startups considering that these formations are better at being agile and risk-taking and are known for their culture of experimentation and the vision of the founders. Established firms recognise they have much to gain from creating partnerships and engaging with the innovation space (Huizingh, 2011; Stanko *et al.*, 2017). Within this context, different forms of linkages among incumbent firms and startups have appeared and expanded from dyadic partnerships to ecosystem levels (Öberg and Alexander, 2019).

Based on this background, this case study concerns an innovation programme where an incumbent firm opens us the innovation process and expresses the interest to work with a group of startups to co-develop innovative solutions and solve specific business issues. This process takes place under the coordination of a university incubator that serves as an ecosystem orchestrator. As an ecosystem actor, the university applies its intellectual, reputational and financial capital strategically to establish and maintain a strong ecosystem (Heaton *et al.*, 2019). The result of this process is called the "co-creation". As such, the system that is formed by the incumbent firm, the startups and the university can be considered as an IE, specifically a "hub-based IE" because it involves an organisation assuming ecosystem leadership and exercising influence over the strategies of other members (Nambisan and Baron, 2013). Participating actively as facilitators of the innovation programme helped us obtain exposure to incumbent companies and startups at a level of detail required for achieving a deep understanding on incumbent/startup collaboration and the contradictions within such an IE.

The case was initiated by the Information Technology and Telecommunications (IT&T) Business Unit of an Airport Company. Paving the way for technological innovation in aviation and tourism, the company has invited startups to submit innovations and create new and innovative products, services or processes. While the initial vision was to innovate in core airport operations, the ecosystem evolved and designed several products and services that catered to the broader environment and added complementary offerings. Some examples of the challenges given were: enhancing airport operations, from improving information exchange and decision-making, to upgrading passenger processing, air traffic control and meteorological forecasting. During the six-month programme, the incumbent firm closely collaborated with the startups to co-develop and commercialise digital innovations. The incumbent firm had to work closely with them and integrate their innovations with the R&D activities and business model. The process involved several iterations in the broader spirit of agile development where startups would develop a product with the help of the ecosystem, use incumbent market access to validate it, make adjustments and try to find a suitable business model for the co-creation

that is mutually beneficial. In the end, the company had to decide on the type of partnership with the entrepreneurial venture and the commercialisation mode of the digital innovations.

The programme constitutes a recurring effort with new startups entering the ecosystem every year. However, we choose to analyse these specific startups in the context of our theoretical sampling. The case can be considered "exceptionally revelatory and exemplary" (Eisenhardt and Graebner, 2007; Yin, 2009), in the sense that the companies acted inside the IE for an extended period of time with varying end results, and were very open to discuss and share their progress with researchers. Table 1 presents the context for the case.

Following Granstrand and Holgersson's (2020) definition, the programme in question constitutes an ecosystem, as it contains all the different elements needed to form and IE. Specifically, it is formed by (1) an institution, namely, a university, that sets the rules and facilitates the necessary processes; (2) it contains as actors an incumbent and several startups; (3) that performs several activities such as the exchange knowledge and data, the sharing of technological equipment and occasionally facilities; (4) to create common artefacts that are co-developed products or services, to address their markets.

Within this IE, Table 2 list the five guiding principles that underpin the AT (Engeström, 1987) and maps their relevance to the context of this study.

3.2 Data collection and analysis
To gather the bulk of data, this research combined multiple sources of data collection that lends greater support to the conclusions. Hence, the following techniques were chosen as the most appropriate:

3.2.1 Semi-structured interviews. Interviews and discussion with members of the startups and the incumbent firm that were involved in the innovation process were conducted. More specifically, ten semi-structured interviews of about 30–45 min were conducted with key personnel (Table 2), focusing on their expected knowledge about specific factors that hinder the successful implementation of the innovation process. This technique is suited to case study data collection and particularly for exploratory research such as this, as it allows expansive discussion to illuminate factors of importance (Dennehy and Conboy, 2019; Oppenheim, 1992). The interviewees were all involved in the innovation project, coming from three different sources. Firstly, the organisational committee responsible for guiding and facilitating the project; second, the incumbent firm, whether that was the project team or associate partners who were involved with the co-creation's implementation; thirdly, the startups. The roles were chosen specifically to give the most diverse outlook possible in terms

Innovation vertical focus/challenges	Airport operations and processing, passenger experience, retail management, airport security and crisis management, green airport and energy saving, smart airport, big data and digital technology innovation
Duration	June 2017–January 2018
Number of companies involved	1 incumbent firm and 3 startups
Innovation process	Agile, prototype quickly and fail fast
Mindset	Disruptive innovation ideas
Politics/culture	Politics tends to play a lesser role within the layers of management, bureaucratic nature, is epitomised by policy manuals, HR inductions, job descriptions, handbooks and endless reams of meetings
Decision-making process	Delegate decisions to committees or sub-committees, centralised and "informed as much as possible"
Openness and transparency	Sustaining a transparent working relationship, openness between supervisors and employees
Structure/layers of management/authority	Fewer layers of management but centralised decision-making

Table 1.
Background to the case

Types of contradiction (Engeström, 1987)	In the context of an IE
Level 1: primary contradiction – when activity participants encounter more than one value system attached to an element within an activity that brings about conflict	When the incumbent's project team and the startup have different visions about the co-developed innovation
Level 2: secondary contradiction – when activity participants encounter a new element of an activity, and the process for assimilating the new element into the activity brings about conflict	The collaborative pilots involve real co-working and adapting the existing processes to allow for testing the co-creation
Level 3: tertiary contradiction – when activity participants face conflicting situations by accepting what is believed to be a newly advanced method for achieving the object	The use of the co-created innovation can vary extensively as different backgrounds and priorities shape how technology is used, thus creating conflict not only between incumbent and startup but also between different teams inside the incumbent firm
Level 4: quaternary contradiction – when activity participants encounter changes to an activity that results in creating conflicts with adjacent activities	If the co-creation is adopted, this disrupts traditional workflows

Table 2.
AT principles within the context of study

of involvement, experience and role, given the project's limitations. A summary of interviewees can be found in Table 3. The gathered data were analysed to pinpoint contradictions evident in the innovation process. The questions asked were open-ended to allow more freedom of expression in an effort to accurately capture the complexities of operating inside an IE. Notes were also taken based on indirect participant observation (Bryman, 1989) as interactions and situations unfolded during the study.

3.2.2 Personal observations and shadowing of the innovation process. Researchers spent a great deal of time and effort to analyse the factors that hinder the successful implementation of the innovation process and identify those that are troublesome and can be improved. This was accomplished by interacting in a day-to-day manner with the team members of the incumbent firm and the startups. Based on these observations, the research team was able to gather data about their interactions, collaborations and general progress throughout the six months of the innovation programme.

3.3 Threats to validity
As this hypothesis is still at an exploratory stage, this work was primarily focused on testing the compatibility of the AT with IEs and presenting an initial steppingstone towards further exploring the inner working and specifically contradictions of such systems using this

| No	Interviewee job title	Company
1	Innovation project owner	Incumbent firm
2	Innovation project team member	Incumbent firm
3	Business unit that the innovation will be applied	Incumbent firm
4	CEO	Startup 1
5	CTO	Startup 1
6	CEO	Startup 2
7	CTO	Startup 2
8	Marketer	Startup 2
9	CEO	Startup 3
10	Developer	Startup 3

Table 3.
Interviewee profile

approach. However, to the extent that is possible, this work tries to address the four common types of validity tests, specifically construct validity, internal validity, external validity and reliability validity (Runeson and Höst, 2009).

Construct validity is concerned with obtaining the right measures for the concept being studied (Runeson and Höst, 2009; Dennehy and Conboy, 2019). The researchers used data two types of triangulation to address this threat, namely, data triangulation and observer triangulation (Stake, 1995). More specifically, three different data sources were used throughout the course of the projects, and three researchers were involved in gathering and interpreting the data. Internal validity is of concern when causal relations are examined (Runeson and Höst, 2009; Kitchenham *et al.*, 2002). As this threat applies to explanatory or causal studies only and not to descriptive or exploratory studies (Yin, 2009), it was not a threat in this study. External validity is concerned with the extent that the results can be generalised and relevant to people outside the research's confines (Wohlin *et al.*, 2003; Runeson and Höst, 2009). This is challenging for qualitative research and case studies in particular (Yin, 2009). Even more so, because this work aims to be an initial test of compatibility of the AT with IEs. However, the purpose of this work is to propose a new theoretical background, with an initial application based on the background proposed by Eisenhardt and Graebner (2007), and not to test it aiming to generalise it. Therefore, external validity was not explicitly sought out. It is the authors' aim, however, to further test external validity in future research as more cases are tested and incorporated to generalise the proposed theory. Finally, reliability validity concerns the extent to which the data and the analysis are dependent on the specific researchers (Runeson and Höst, 2009). Once again, we acknowledge that this cannot be fully addressed within the limits of this work, but to mitigate this threat, three researchers were involved with the interpretation of the gathered data, and the findings were reviewed by executives.

4. Results

This work presents two main sets of results answering the two research questions identified in the introduction. As a first result, we present the AT as a framework to conceptualise an IE in a way that allows for further research into the various in the interconnections within the system. This is done using the notion of interrelated activity systems (Figure 2) and essentially gives a framework that permits researchers to conceptualise and explore ever-complex systems while being able to simultaneously identify elements both in the system and company level. As a second result, we present several contradictions of all levels that were identified within the researched IE. These contradictions were identified using the manifestations proposed by Engeström and Sannino (2011). These manifestations serve to
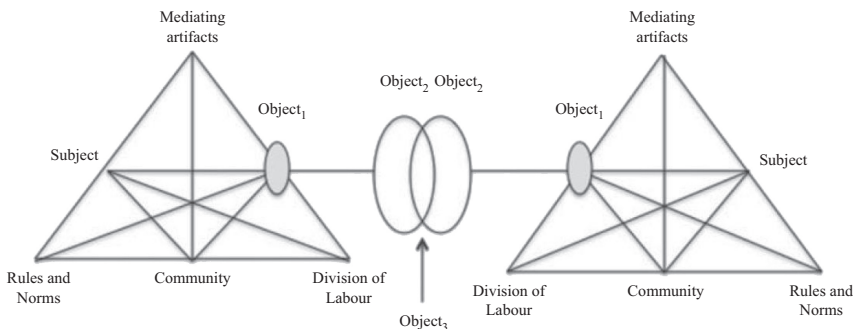
Figure 2.
The interrelated
activity systems

further our understanding of IEs as social constructs and the factors that affect their performance.

4.1 Conceptualising incumbent/startup innovation ecosystems as interacting activity systems

Based on the AT's theoretical background, we conceptualised the companies acting within the IE as activity systems interacting amongst them to create a product. An instantiation of the interacting activity systems in this study is presented in Figure 3. In this case, we first examine only the binary set of incumbent and one startup.

Starting from the left-hand side, a startup taking part in an IE is depicted as an activity system. The object of this activity is: to convey the essential validation of their innovation for market fit and future customer acquisition, test their solution, pivot swiftly their product and adopt it to a specific business problem. The co-founders (as acting subjects) use tools such as their tech skills and agile methodologies to manage the development of their innovative product/service. The success of these actions (outcome) is mediated by factors such as the norms and rules (e.g. affective commitment, entrepreneurial culture and agility) governing a startup venture. Tools (e.g. workflow management system, collaboration tool, agile methodologies) mediate and support this activity. Coordination of activities within the activity system is influenced by division of labour (job title and associated responsibilities) between members of the community (team members of the entrepreneurial team) and the subject (co-founders).

Within the IE, the startup activity system is further influenced by interactions with the incumbent activity system. Concerning the right-hand side, an incumbent company that takes part in an innovation process is also depicted as an activity system. The acting subjects are the OI project owner and the management team (e.g. employees in the established organisation). The object of this activity is: develop new technologies/solutions with less costs and risk, expand to new markets and create entrepreneurial culture. Market knowledge and experience, economies of scale, established networks, brand power and financial resources mediate the work of this community. The outcome of the activity is mediated also by factors such as the norms and rules (such as hierarchical structure, centralised decision-making, bureaucratic nature) and the division of labour, which tends to be less risk-averse and is characterised by policy manuals, HR inductions, job descriptions, handbooks. The correspondence of the AT constructs to elements of the IE is demonstrated in detail in Table 4.

At first, members of both activity systems have their own "viewpoint" (Object$_1$) of what the innovative technology/solution is about and how best to adapt it in the real environment. As the OI project progresses, a collective understanding of how to implement the innovation
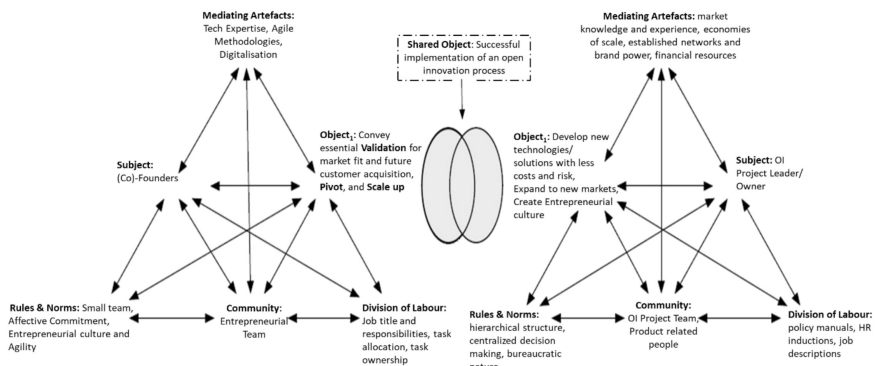

Figure 3.
IE actors as interrelated activity systems

(Object$_2$) is built by the interacting activity systems. Finally, this is followed by the joint implementation of the innovation via a sense of shared ownership (Object$_3$) by members of both interacting activity systems.

Figure 4 shows the structure of the studied IE as a whole, using the concept of "shared objects", i.e. the co-created innovation, as the linking factor between the different actors all under the context of a recurring innovation programme (institute).

In this more complex depiction, the basic principles remain the same: different companies represent different activity systems with their subjects, objects, rules and norms, mediating artefacts, communities and division of labour. All interact to co-create objects that exists within a common IE. In this sense, the co-creations are affected not only by the activity systems that create them but also from every other dyadic relationship between an incumbent and startup or even a startup and a startup.

While this work focuses on a smaller instantiation of an IE, namely, one incumbent and three startups, the proposed concept can be generalised to study larger ecosystems connecting the various entities that affect the innovation process.

### 4.2 Contradictions that hinder incumbent–startup activity systems

Other than conceptualisation IEs as sets of activity systems, this paper uses the AT to identify contradictions that affect the processes of an IE. As was previously mentioned, this important for IEs because of their highly social nature that breeds contradictions, a concept that is not so evolved in other social theories (Dennehy and Conboy, 2019).

These contradictions were identified using linguistic cues for discursive manifestations, as proposed by Engeström and Sannino (2011). Consequently, in the interviews and scripted interactions, we focused mainly on identifying dilemmas, conflicts, critical conflicts and double binds. Table 5 summarises the identified contradictions based on their level and how they manifest it; these findings are analysed in detail below with indicative examples from the data.

1.1. Misalignment of strategic aim

AT constructs	Relevance in the IE
Shared object	At first, members of both activity systems have their own "viewpoint" (Object$_1$). The object of the startup activity is: to convey the essential validation of their innovation for market fit and future customer acquisition, test their solution, pivot swiftly their product and adopt it to a specific business problem. The object of the incumbent activity system is: develop new technologies/solutions with less costs and risk, expand to new markets and create entrepreneurial culture. Finally, the members share the same viewpoint, i.e. the successful implementation of the new product co-development
Tools	Tools such as their tech skills and agile methodologies manage the development of their innovative product/service. Market knowledge and experience, economies of scale, established networks, brand power and financial resources mediate the work of this community
Subject	The co-founders are the subjects within the startup. The acting subject within the incumbent is the OI project owner
Rules and norms	Concerning the startup, the norms and rules are affective commitment, entrepreneurial culture and agility. The norms and rules within the incumbent are hierarchical structure, centralised decision making, bureaucratic nature
Community	The community within the incumbent consists of the management team (e.g. employees in the established organisation)
Division of labour	Concerning the incumbent, the division of labour tends to be less risk-averse and is characterised by policy manuals, HR inductions, job descriptions, handbooks

Table 4.
AT constructs in the IE
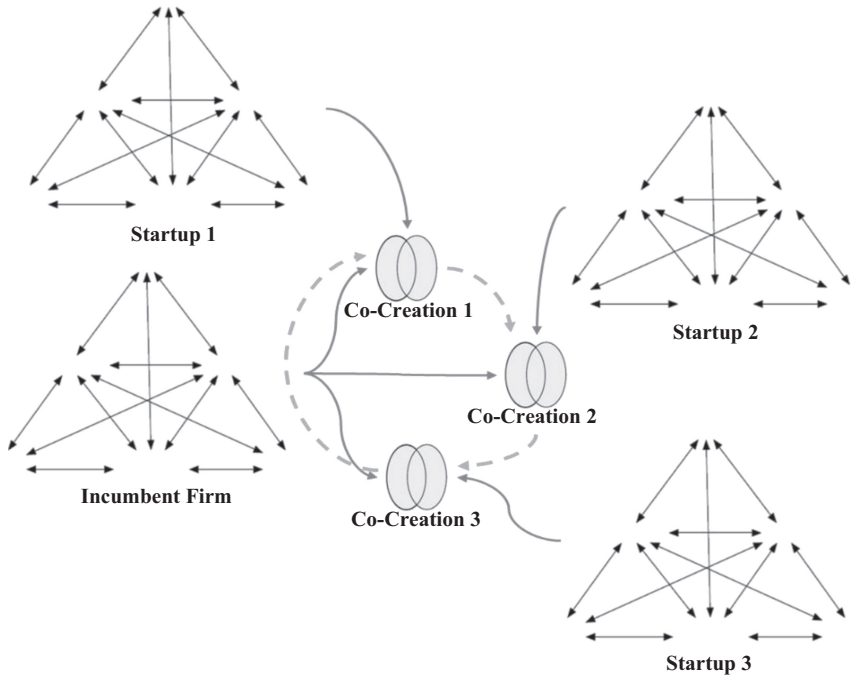
Figure 4.
The studied IE
conceptualised using
the AT

Contradiction level	Contradiction		Manifestations
1	(1)	Misalignment of strategic aim	Critical conflict, double blind
	(2)	Difference in values	Conflict
	(3)	Participation to the idea development process	Conflict, critical conflict
2	(1)	Misalignment of tools and workflow	Critical conflict, double blind, dilemma
	(2)	Insufficient commitment	Conflict
	(3)	Lack of intellectual property agreement	Double blind
3	(1)	Negative attitudes towards the innovation process	Critical conflict, dilemma
	(2)	Measuring innovation	Conflict, critical conflict
4	(1)	Incentives	Dilemma
	(2)	Complementarity competencies and experience	Conflict, double blind

Table 5.
Contradiction levels
and manifestations

A common occurrence was problems and misunderstandings arising from the fact that startup and incumbent did not share an aligned vision for the project. As such, the strategic aim was different pulling the co-creation towards different directions and creating friction between the collaborating teams. All these differences contribute to each community not fulfilling the expectations of the OI process. Unfulfilled expectations are an important cause that hinders the success of the IE:

> They had limited vision. They did not want to fully incorporate our solution into their systems but rather use it as complimentary service to spice-up customer experience.

Questions like for which purpose is OI used for and what is the scope of the project need to be answered to mitigate contradictions across the teams.

1.2. Differences in values

Contradictions can also be the result of differences in corporate values and perceptions concerning the collaboration and the way the co-creation will be implemented. Essentially, the companies' background and mentality can create obstacles due to implicit priorities and goals that exist as a result of the different ideas and history of both the firms and the people involved:

> Our goal is to provide our customer the best possible experience. An MVP is OK but not good enough.

While it is very hard to align corporate values, being mindful and managing the differences can be crucial for the co-creations general direction.

1.3. Participation to the idea development process

Within the OI process, often, the co-founders who have submitted the initial idea have strong opinions and knowledge about how to proceed with it. The acting subjects are keen on developing the idea; however, it is important for the employees of the established organisation to be part of the idea development process. When either organisation took lead without the other being completely onboard, this was perceived as an effort to hijack the process:

> They were very set in what they wanted. [. . .] For a big part of our collaboration executive decision were just announced [. . .]. We seriously considered dropping out at many points.

> It took some convincing, but they saw that their ideas were unrealistic, and we went on with our plan.

An onboarding process seems to be necessary at least for some executive decisions. The existence of the university as a trusted third party seemed to help the process.

2.1. Misalignment of tools and workflow

Startups have a very unique, almost infamous, way of conducting their daily business. Processes and workflows can be extremely different to established firms even if both are following agile methods. Conflicting workflow management mindset and practice can be a source of delays and miscommunication. This was exacerbated by a persisting conviction that a "workflow management agreement" was unnecessary as each firm had its own established flows. To avoid contradictions, the acting subjects within the interacting activity systems should illuminate the work process by clearly defining how they will collaborate and ensure a common understanding of timeline, processes, responsibility for setting up each task:

> It took us about a month to finally understand who does what and even after that it still was not clear who is the corresponding person for the other side [i.e. the other firm]

> It is the 21st century and they wanted us to go full waterfall. . .

> We understand the benefit of agile, but it is unrealistic to implement such methodologies in an established workflow.

It is understandably difficult to change ones establish workflow to accommodate a collaborative process. It seems, however, that having a clear agreement that describes the "work conditions and ways of collaboration" and as a roadmap when things do not go as planned can help avoid obstacles in the implementation of the new technology.

2.2. Insufficient commitment

Another contradiction between startup and incumbent team can arise from the possible lack of motivation and commitment to the innovation project. In some cases, the employees of the established company were just observing the startup but not really facilitating the collaboration. Motivation can drop at any point of the innovation process, making it very important to maintain constant focus on enhancing and rewarding engagement. As for the startups, the entrepreneurial team works many hours a day to develop the new product, but there are is usually no monetary return. To keep people on board, the emotional connection with the entrepreneurial endeavour and the shared vision of a successful implementation are of utmost importance.

At some point we felt like interns being assigned the whole project without any direction.

It was too much work and the team really started to lose interest and question both the project and our idea.

Defining a common list of expectations regarding each other's time commitment level may prevent from misunderstandings, disagreements and eventually contradictions.

2.3. Lack of intellectual property agreement

When it comes to innovative products and prototypes, intellectual property rights are more or less always on the table. The purpose of an intellectual property agreement is to certify the inventor has the right to be recognised and profit from their innovations. Within the OI process, the entrepreneurial team must give consent to the established organisation to have the rights to develop and implement the innovation. Successful OI benefits both parties and is fair for everyone. The lack of intellectual property agreement and alignments for specific future scenarios are important aspects that can lead to contradictions and negatively affect the successful implementation of the OI process. Such agreement should describe ownership structure, initial capital and additional contributions, management and legal decision-making:

[In the beginning] we were afraid that they would just steal our product and do it on their own.

3.1. Negative attitudes towards the innovation process

Sometimes, an issue that hiders the successful implementation of an innovation derived from an IE can be a negative attitude towards something that was not invented in-house. It was frequently observed that the entity who was against OI and collaboration was sceptical of quality issues. There is still a lingering perception amongst executives (especially in established firms) that services provided by emerging startups are of lower quality or startup members have limited expertise. Such attitudes can result to inflexibility, which is opposite to the whole concept behind OI. Sometimes, negative attitudes towards OI can also originate from uncertainty:

We really like the product the product but what happens when it eventually breaks down. I will have to explain why I chose them over going to [established manufacturing firm].

Perhaps, the community within the incumbent company believes that their position is threatened, or simply just are not truly aware of the real benefits of co-creation.

3.2. Measuring innovation

Innovation is by its nature hard to measure. It became evident that as different people understood innovation differently (even within the same firm), there was rarely a consensus

of whether the work was innovative or not. While innovation might not be an end in itself, those operating with an IE felt that they have to produce something new and disruptive; otherwise, they were wasting time and resources. This was especially true for upper management of the established firm that wanted to see results with "a wow factor" without defining what that would entail:

This is not new. I have seen this before.

Why are we wasting time with ideas that we have been tried in the past?

It is essential to understand that innovation has many manifestations, and it is not as simple as inventing a new product. It can take the form of a process or even be an adaptation of something that is thoroughly used in another field. In all scenarios, expectations management at all levels is essential.

4.1. Incentives

Another important issue that can lead to contradictions is that of incentives. To enhance motivation and commitment to the OI process, it is important to give some type of reward that can motivate and is aligned with the new product development. This does not necessarily translate to a monetary reward. In some cases, the simple act of recognising one's efforts publicly was enough for employees to be more committed, participate and keep them engaged in the project. As the collaboration in an IE creates extra value for the firm, the employees who drive this forward need to receive an extra for their effort. In cases where the employee was expected to collaborate within the context of his day job, the OI project was seen as just extra work added to their workload. However, those who received some type of bonus for their effort were pleased and more eager to recommit to future collaborations, thus strengthening the sustainability of the created IE:

This was a nice distraction, but we already have too much work. [. . .] it would be better if it [the project] worked with people whose job description involves this type of work.

Sometimes, people might be exited to collaborate with a new venture to learn new things. Others, on the other hand, might already know a lot about the topic but have not had the chance to participate in real projects or access real data they find interesting. This type of internal incentive was observed in some cases that also expressed interest to continue the collaborative relationship. It was, however, mainly observed with people that were involved in high level aspects of the IE and did not deal with the routine day-to-day processes:

It is so exciting to see and do new things that we never get to do in our work.

4.2. Complementarity competencies and experience

Complementary competencies were seen to work both as a bonus and a handicap in different situations. In some cases, the collaborating teams had no overlapping expertise. This led to communication gaps as different tools and ideas translate differently across disciplines and knowledge that might be considered a given in one discipline might be exotic in another. In many cases, the work could not move forward as one team did not understand what was required to help the other:

It took them three meetings to understand that we already had the data and just needed to access their API.

Marketeers. . . Always focussing on fluffy, irrelevant things.

On the other hand, in cases where there was an overlapping expertise, there were incidents where all would claim deeper knowledge without willingness to compromise:

> We have been working on data analytics for years now! We know what works and what not. [. . .] it is a nice approach, but we will lose more time.

It is evident that this is a complicated contradiction to address. As with all social interactions, people who are willing to compromise and concede when they are wrong are needed. The help of a trusted party managing the IE also seems to help.

5. Discussion
This paper uses an interdisciplinary approach to bring the AT into the context of an IE. Through this process, we aim to provide a novel for the filed theory that will allow researchers to conceptualise IEs and explore their inner workings on multiple levels. This theoretical hybrid also allows us to identify contradictions within IEs that are very relevant to what is defined as conflict in entrepreneurial literature. As such, this work can serve as a basis to further explore the field of IEs from a new perspective that takes into account the social interactions and the social construct that is a company, a startup, a university and the ecosystem in general.

5.1 Activity theory perspective
In terms of the AT, this paper demonstrates that the AT (Engestrom, 1987) is suited to conceptualise the interactions between interconnected organisations, particularly in an incumbent–startup context. It illustrates how such collaborative activity is enabled or constrained by interacting tools, rules and norms and divisions of labour. Consequently, it provides researchers with a theoretical and methodological frame for reporting contradictions (Engeström and Sannino, 2011) when an incumbent firm cooperates with a startup to co-develop an innovative solution. It enables the researchers to signify the "multi-voicedness" of the interacting activity systems (Karanasios, 2018) as multiple points of view, motives and perceptions. In doing so, the researchers are able to examine the ways in which contradictions materialised in the innovation process. This is important, as it enables a deeper understanding of why the co-development of technological innovations can fail or succeed in practice.

5.2 Practical implications for contradictions that hinder incumbent–startup collaboration
This work also identifies several practical implications for IEs. By conceptualising the collaborative innovation process as a set of interacting activity systems, this paper highlights the need to achieve a deep interconnection between incumbent and startups' rules and norms, division of work and tools. If the innovation product is to be sustainable, it is necessary to create a shared ownership within and between members of the interrelated activity systems (Charaf et al., 2013). The following contradictions were identified: (i) misalignment of strategic aims, (ii) differences in values, (iii) participation to the idea development process, (iv) insufficient commitment, (v) lack of intellectual property agreement, (vi) negative attitudes towards OI, (vii) measuring of innovation, (viii) incentives, (ix) misalignment of tools and workflow, (x) complementarity competencies and experience. This list is revealing but not exhaustive. This research directs attention to all these issues when an incumbent firm works with a startup to co-develop a technological innovation. They represent sources of developmental tension and systemic contradiction in the interacting activity systems.

Essentially, during this study, it was made evident that even companies that were very willing to be involved a collaborative ecosystem were hindered by their background and

legacy elements that they did not consider significant. Proclaiming openness was balanced out by an innate fear of divulging know-how or expertise, both in the case of incumbent and startups. Issues surrounding the "doing business status-quo" became very hard to consolidate as all sides were reluctant to try something different that would facilitate collaboration. How well different personalities matched, or were managed, became crucial as the co-creation process moved forward. This work proposes that forming collaborative schemes that are mindful of these elements can become more effective ecosystems in terms of innovation, collaboration and sustainability. While this is something unattainable in ecosystems where there is no form of central control, it is possible in IEs where a trusted institution (e.g. a university) acts as a coordinator. This is also an element that was seen to mitigate and help resolve the aforementioned contradictions after they were observed. As the OI project organiser was a university with no vested interest other than accommodating the process, it was easier to act as a mediator resolving conflicts and ensuring the sustainability and results of the IE.

5.3 Level of contradictions and collaboration scheme
Another interesting outcome of this paper is the idea that when an incumbent company cooperates with a startup to develop an innovation, different schemes of collaboration may emerge. These schemes include: innovation procurement, which acts as partnership with a specified contract; investment with shareholding agreement; and acquisition of the startup from the incumbent firm. This paper implies a variation from one mode to another based on the level of contradictions that occur. When tertiary or quaternary contradictions occur, this implies that a long-term relationship by acquiring or investing in the entrepreneurial venture could take place. Otherwise, when first- or second-level contradictions occur, conflicts in terms of values and perceptions are present, and thus, a long-term agreement is harder to be achieved.

Table 6 describes the outcomes of the collaboration between the airport company and the entrepreneurial ventures and the contradictions observed, and this is a matter of future work.

The innovative product offered by Startup 1 is a weather/air pollution monitoring system based on the internet of things (IoT) technology. It consists of portable equipment, which enables the respective personnel to perform low-cost, easy-to-deploy environmental measurements in various locations within and outside of the airport. During the innovation process, Startup 1 worked jointly with the incumbent company to understand how the proposed innovation can be aligned with the airport company's technologies and business model. This technological innovation is complimentary to the existing infrastructure of the airport company and provides value-added knowledge about weather conditions, air and noise pollution levels. During the innovation process, Startup 1 and the incumbent firm decided to enter into a commercial supplier–buyer agreement where a procurement contract was signed among the two.

The innovative solution offered by Startup 2 involves the effective planning, monitoring and managing of daily personnel work, as well as emergency management. This technological innovation targets the core business of the incumbent organisation but requires more effort from the corporate side and higher levels of co-creation to produce a final product/service. The collaboration scheme that was observed is that of co-development and partnership with a shared revenue model. This can also be expanded to acquisition in the future.

The innovative service offered by Startup 3 tries to improve passenger experience. By using this service, the passenger receives notifications of the exact time of arrival of his/her bus at the stop. It is also informed of problems in its line, of punches and closed roads. The goal is for the passenger to plan the movements in a timely manner without unnecessary

Collaboration between incumbent and...	Relevance to the incumbent core business	Degree of engagement and co-creation	Collaboration mode	Leverage analysis and expected outcomes	Most important contradictions observed[a]
Startup 1	Low relevance – peripheral business	High	Commercial supplier–buyer agreement	Entering new market, enhancing company's brand, rejuvenating corporate culture, solving business problems	i, v, ix, x
Startup 2	High relevance – core business	High	Partnership, shared revenue model, product co-development	Accessing specific skills and talent, entering new market, solving business problems	iii, vi, viii
Startup 3	Low relevance – peripheral business	Low	No commercialisation mode	Enhancing company's brand, rejuvenating corporate culture	i, ii, iv, vii, ix, x

Table 6.
The outcomes of the collaboration between the incumbent firm and the startups

Note(s): [a]Numbering is based on the categorisation presented in "Practical implications for incumbent-startup collaboration"

waiting. This innovation is not relevant to the core business of the incumbent firm, but it could be promoted as a corporate social responsibility (CSR) initiative towards the local community. During the innovation process, there was a lack of commitment of the team of the incumbent firm for the innovative product offered by Startup 3. The main reasons can be summarised as: lack of trust and lack of a shared vision between the incumbent firm and the entrepreneurial venture, contradictory goals and no consensus, existence of a manipulative member of the startup that triggered endless discussions. As a result, no synergy was observed.

6. Conclusion, limitations and future work
Innovation research has moved from a focus on single innovator company to an approval of a collective nature of innovation. Based on a qualitative case study and using the AT perspective, this research tries to explain the contradictions that hinder the successful implementation of an innovation process when an incumbent firm cooperates with a startup to develop a technological innovation.

The incumbent–startup context can be regarded as an exceptional and significant setting in which to study IEs, as it differs significantly from a well-established network or community. By applying the principles of the AT and gathering data of ten members, this

research tries to contribute to the domain of research, i.e. about IE and incumbent–startup collaboration. To sum up, the implications of this research are the following:

(1) propose the AT framework as a tool to study the factors affecting the collaboration of entities within an IE.

(2) identify important contradictions that hinder the successful implementation of an innovation process within an incumbent–startup context.

As such, the novel aspects in our study are: the introduction of the AT in the IE field, the focus on the incumbent–startup context for extending the IE literature, the collection of primary data, the identification of contradictions that occur between an incumbent and a startup.

There are three main limitations to this work. First, this study examined an IE formed within a structured OI project. While this is a form of IE, other more fluid ecosystems might shift focus to different contradictions.

Second, the IE is centred around one established firm. Although there was interaction throughout the formed ecosystem, the nature and identity of the incumbent played a very important role on the way the system progressed. Consequently, different firms could possibly give rise to other contradictions as well. While it is our belief that the AT can be applied to various forms of IEs, given the structural integrity of hub-based ecosystems, we suggest that future work firstly focuses on this section of IEs. As with our case, where a university plays the role of the coordinator, hub-based IEs can be simpler to navigate and allow for easier access to data.

Third, all the personnel of the parties involved entered the collaborative scheme willingly and with conviction (at least initially) to make this process work. Scenarios where the personnel of different firms are not choosing but are forced to be involved might also give rise to different sets of contradictions.

Future work is needed to correlate the different level of contradictions with different schemes of collaboration. It is also important to study bigger IE and generalise findings to the extent that is possible. Finally, more research is required to, not necessarily larger but, more complex IE where more than one established firm is involved.

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