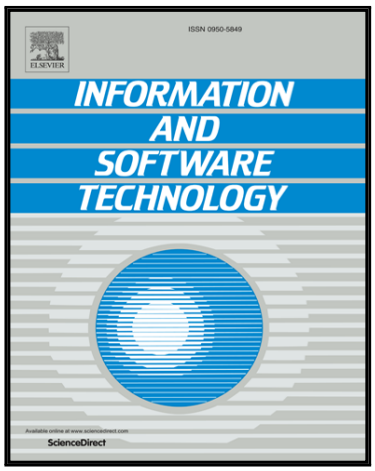


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# Insights into Startup Ecosystems through Exploration of Multi-vocal Literature

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**Abstract**

Context: Successful startup firms have the ability to create jobs and contribute to economic welfare. A suitable ecosystem developed around startups is important to form and support these firms. In this regard, it is crucial to understand the startup ecosystem, particularly from researchers' and practitioners' perspectives. However, a systematic literature research on the startup ecosystem is limited. Objective: In this study, our objective was to conduct a multi-vocal literature review and rigorously find existing studies on the startup ecosystem in order to organize and analyze them, know the definitions and major elements of this ecosystem, and determine the roles of such elements in startups' product development. Method: We conducted a multi-vocal literature review to analyze relevant articles, which are published technical articles, white papers, and Internet articles that focused on the startup ecosystem. Our search generated 18,310 articles, of which 63 were considered primary candidates focusing on the startup ecosystem. Results: From our analysis of primary articles, we found four definitions of a startup ecosystem. These definitions used common terms, such as stakeholders, supporting organization, infrastructure, network, and region. Out of 63 articles, 34 belonged to the opinion type, with contributions in the form of reports, whereas over 50% had full relevance to the startup ecosystem. We identified eight major elements (finance, demography, market, education, human capital, technology, entrepreneur, and support factors) of a startup ecosystem, which directly or indirectly affected startups. Conclusions: This study aims to provide the state of the art on the startup ecosystem through a multi-vocal literature review. The results indicate that current knowledge on the startup ecosystem is mainly shared by non-peer-reviewed literature, thus signifying the need for more systematic and empirical literature on the topic. Our study also provides some recommendations for future work.

*Keywords:* Startup, Ecosystem, Startup Ecosystem, Software Startup, Multi-vocal literature review, Systematic literature review

## 1. Introduction

In the new global economy, startup firms have been considered a key player in economic development. The reasons for their significance are their contributions to job creation (which increases employment) [1] and economic growth at the regional, national, and industrial levels. Several breakthrough innovations and major businesses have been generated by startups [2, 3]. The elements comprising a region's entrepreneurial environment play an important role in the successful development of startups, such as Silicon Valley, a region that is well known for its successful startup creation. The elements of such an environment need to interact together as an ecosystem that can nurture the creation of successful startups [3, 4]. In a biological ecosystem, species interact with one another and with nonliving elements in their environment [5]. Over the past three decades, there have been rapid developments in the concept of the ecosystem. When applied in the business field, the concept is called a business ecosystem, in which companies collaborate in the form of relationships to create value for customers [6]. Similarly, a startup ecosystem refers to the phenomenon in which startups and their supporting elements interact in an environment that is built to foster these startups' development and growth. However, concrete evidence of a systematic and detailed study that can provide an overview of the startup ecosystem literature and the phenomenon itself is limited or unknown [7, 8]. The lack of a synthesized overview on exiting definitions and knowledge of the startup ecosystem framework indicates a research gap and poses a challenge in the conduct of further studies. As startups perform a significant role in economic growth, it is important to know the experiences shared by researchers and practitioners in the startup ecosystem by obtaining collective knowledge from different perspectives. To address the research gap, we sought to analyze the startup ecosystem literature in a systematic way in order to evaluate evidence on it. Our study's main objectives were to identify the following:

- the definitions of a startup ecosystem
- the important elements constituting a startup ecosystem
- the roles that these elements play in startups' product development stages

To achieve our objectives, we proposed three research questions (RQs) (see Section 3.1). To answer these RQs, we conducted a pilot study in which we searched for an initial set of keywords in two electronic databases. The search generated limited results in terms of peer-reviewed literature, showing that

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the startup ecosystem has not been explored sufficiently in academic studies. Hence, we opted to expand our search process in order to collect gray literature (to include practitioners' viewpoint), along with technical research articles. To do so, we conducted a multi-vocal literature review [9, 10] to broaden the research data with such sources as technical articles, white articles, books, or web pages with respect to the startup ecosystem. Out of 18,310 sources found, the multi-vocal literature review revealed 63 articles as primary study candidates. With these primary study articles, our research aims to organize and analyze the literature on the startup ecosystem, how it is defined, what its elements are, and how such elements contribute to startups' product development. The remaining sections of this paper are organized as follows. Section 2 provides the background and related work. Section 3 explains the research method that we used to conduct the multi-vocal literature review. Section 4 presents our findings on the startup ecosystem. Section 5 discusses the answers to our RQs, the implications of the results for practice and research, the comparison of startup and entrepreneurial ecosystems, and the study's validity. The last section concludes our paper.

## 2. Background and Related Work

In this section, we describe the background literature on startups and ecosystems. Next, we discuss studies that are related in terms of topics and research designs.

### 2.1. Startup and Product Development

Among many other factors, a nation's natural resources, education, political system, and economic growth depend on its industries' ability to create innovative products. The role of startups in this process has been increasing [2]. With respect to startup definitions, Steve Blank [11] defined it as "a temporary organization in search of a scalable, repeatable, profitable business model," whereas Erik Ries [12] stated that it is "a human institution designed to create a new product or service under conditions of extreme uncertainty." Crowne [13] described a startup as an organization with limited experience, working with inadequate resources, and influenced by several factors, such as investors, customers, competitors, and the use of dynamic product technologies.

The products of startups can be classified into two types: hardware-intensive products (also called hardware startups) or software-intensive products (also referred to as software startups). Several studies have been conducted in the context of startups' product development (e.g., [13, 14, 15]). Crowne [13] outlined product development in four life cycle stages, which are startup, stabilization, growth, and evolution. Wang et al. [15] used six product development stages (concept, in development, working prototype, functional product with limited users, functional product with high growth, and mature product) to analyze the distribution of software startups. In addition, our earlier studies, [16, 17], explored the effect of competitor interaction on product development and product idea validation in the startup context.

### 2.2. Ecosystem

An ecosystem comprises a community of living beings whose members interact with one another and with nonliving elements in their environment [5]. The ecosystem concept is also used in the business field, such as a business ecosystem forming a network of companies that collaborate to produce systems that hold value for customers [18]. In their literature review of the business ecosystem, Mäkinen and Dedehayir [6] explored the elements of such an ecosystem and the roles of these elements, as well as business ecosystem evolution, the factors affecting this evolution, and the kinds of strategies developed during evolution. Because of the benefits of the business ecosystem, the concept is applied in the software industry to shift its product line to the software ecosystem. In a software ecosystem [19], different stakeholders, such as companies, competitors, and customers, collaborate to target, market to, or provide value to common customers through the exchange of critical information and ideas in order to create products that hold customer value [20]. In a broad study, Manikas [21] pointed out that software ecosystems were rapidly growing but were still at an immature stage.

The ecosystem concept is also reflected in entrepreneurship. According to Cohen [3], in the entrepreneurial ecosystem, different interdependent actors or components interact to create new businesses through startups in a geographic region. As the author stated,

"Entrepreneurial ecosystems represent a diverse set of interdependent actors within a geographic region that influence the formation and eventual trajectory of the entire group of actors and potentially the economy as a whole. Entrepreneurial ecosystems evolve through a set of interdependent components which interact to generate new venture creation over time." [3]

Fostering a startup and entrepreneurship are two different things but are interreliant. An entrepreneur can create a new business by launching a startup. Cukier et al. [22] defined a startup ecosystem as follows:

"a limited region within 30 miles (or one-hour travel) range, formed by people, their startups, and various types of supporting organizations, interacting as a complex system to create new startup companies and evolve the existing ones." [22]

Therefore, some elements that promote entrepreneurship may be missing when promoting a startup and vice-versa. For example, in a startup, product development occurs and requires dependent elements (e.g., product development methodologies) to support it, which might be missing in entrepreneurship.

### 2.3. Related Literature Reviews

A couple of literature reviews described software development in startups. Paternoster et al. [7] conducted a mapping study to understand existing phenomena in software startups and their use of software engineering practices. They observed that a limited number of high-quality studies existed with respect to software startups, and the use of software engineering practices was based on the startup context. Another literature review by Klotins et al. [8], which focused on the software engineering aspects of startups, found that few research articles

provided evidence of software engineering knowledge in the startup context. Klotins et al. also pointed out that because of the low rigor of the literature, the results could not be applied to other startups.

We also found literature reviews on entrepreneurial ecosystems (e.g., [3, 23]). Cohen's [3] objective was to explore the critical components that could turn a potential entrepreneurial ecosystem into a sustainable one. Aaltonen [23] retrieved articles about the entrepreneurial ecosystem from top-ranking journals and found 10 factors that would help shape the entrepreneurial ecosystem.

However, the closest study to ours in terms of topic was that by Torres and Souza [24], whose literature review used the snowball technique to explore the elements framing the technology startup ecosystem and the relationships within it. They observed that these elements' influence on the ecosystem in terms of positive or negative effects remained open to discussion. From these reviews, systematic reviews, especially in the context of the startup ecosystem, are limited. Our study therefore aimed to address this gap by conducting a multi-vocal literature review [9, 10] to find all the relevant technical articles and gray literature that could help us understand real startup ecosystem cases and attain our research objectives.

## 3. Research Method

Several methods to conduct literature reviews exist, such as a systematic literature review [25], systematic mapping study [26], snowballing [27], and multi-vocal literature review [9]. Among these methods, many researchers in the software engineering field have frequently conducted systematic literature reviews and mapping studies. These methods are used when enough academic peer-reviewed articles about a given topic exist. As discussed in the Introduction section, during our pilot study, we used trial keywords in two databases and found a limited number of peer-reviewed articles on our topic. One reason could be that a startup ecosystem is quite a new topic, and peer-reviewed literature related to it is scarce. Hence, focusing on peer-reviewed articles would not suffice to achieve our research objective. We needed to look for other available literature, often called multi-vocal literature, which could be accessed through search engines. The major advantage of multi-vocal literature is that it includes gray literature, such as Internet blogs, web articles, trade journal articles, and white papers that do not appear in electronic databases. Additionally, because of the limited technical articles appearing during our initial search, the inclusion of gray literature in our study was necessary. Therefore, the multi-vocal research method would suit our purpose. Figure 1 shows the process we followed by considering the guidelines provided in a previous study [28].

### 3.1. Research Problem and Questions (Phase 1)

As discussed in Section 2.3, our study aims to address the problem on the lack of systematic reviews in the context of the startup ecosystem, so we provide an outline of the knowledge reported on this topic (as discussed in the Introduction). To do so, we ask the following RQs, which are answered through the literature review:

**RQ1. How is a startup ecosystem defined in the literature?** The objective of this first question is to know how practitioners and researchers define a startup ecosystem. The answer would also give us a conceptual basis of the startup ecosystem phenomenon.

**RQ2. What elements are present in a startup ecosystem?** Once some information about the definition of a startup ecosystem and research on it are retrieved, knowing what constitutes a startup ecosystem is necessary. This could only be possible by knowing its important elements and their interaction.

**RQ3. Which elements play roles in a startup's product development?** One of the main objectives of a startup is to create an innovative product that could enable its entry into a high-potential target market. Hence, a startup's product development is an essential aspect, and we want to know which elements of it play different roles during product development stages.

### 3.2. Literature Search Strategy (Phase 2)

To look for relevant articles that could help us answer our RQs, we implemented two separate strategies for using keywords and database sources. Our search process started in August 2016 and ended in September 2016. We divided the keywords into two categories, population and intervention, as shown in Table 1. The keywords for the population category were derived from previous literature reviews on startups (e.g., [29]). For the intervention category, we just focused on "ecosystem" as the most common term used to describe related areas of this study. Furthermore, previous literature reviews related to an ecosystem, such as a software ecosystem [30], used only the keyword "software ecosystem" for their database search. The combined population and intervention categories were used as search strings in the data sources to retrieve relevant literature. The first and the third researchers jointly performed the search execution and article selection.

Table 1: Population and intervention

| | Population | Intervention |
|---|---|---|
| Key words | "startup" OR "start-up" OR "early-stage firm" OR "early stage firm" OR "early-stage company" OR "early stage company" | "Ecosystem" |

Regarding the data sources, we used two separate techniques. To look for peer-reviewed literature, we used technical libraries (electronic databases), whereas for non-peer-reviewed literature (gray literature), we browsed Google's search engine [1]. The reason for opting for Google was that it helps in retrieving documents with public access. Furthermore, Google Scholar [2] (a web search engine that provides scholarly literature) was not used because we were already searching peer-reviewed literature from four electronic databases. The electronic databases used in the study were as follows:

[1] http://www.google.com
[2] https://scholar.google.com/

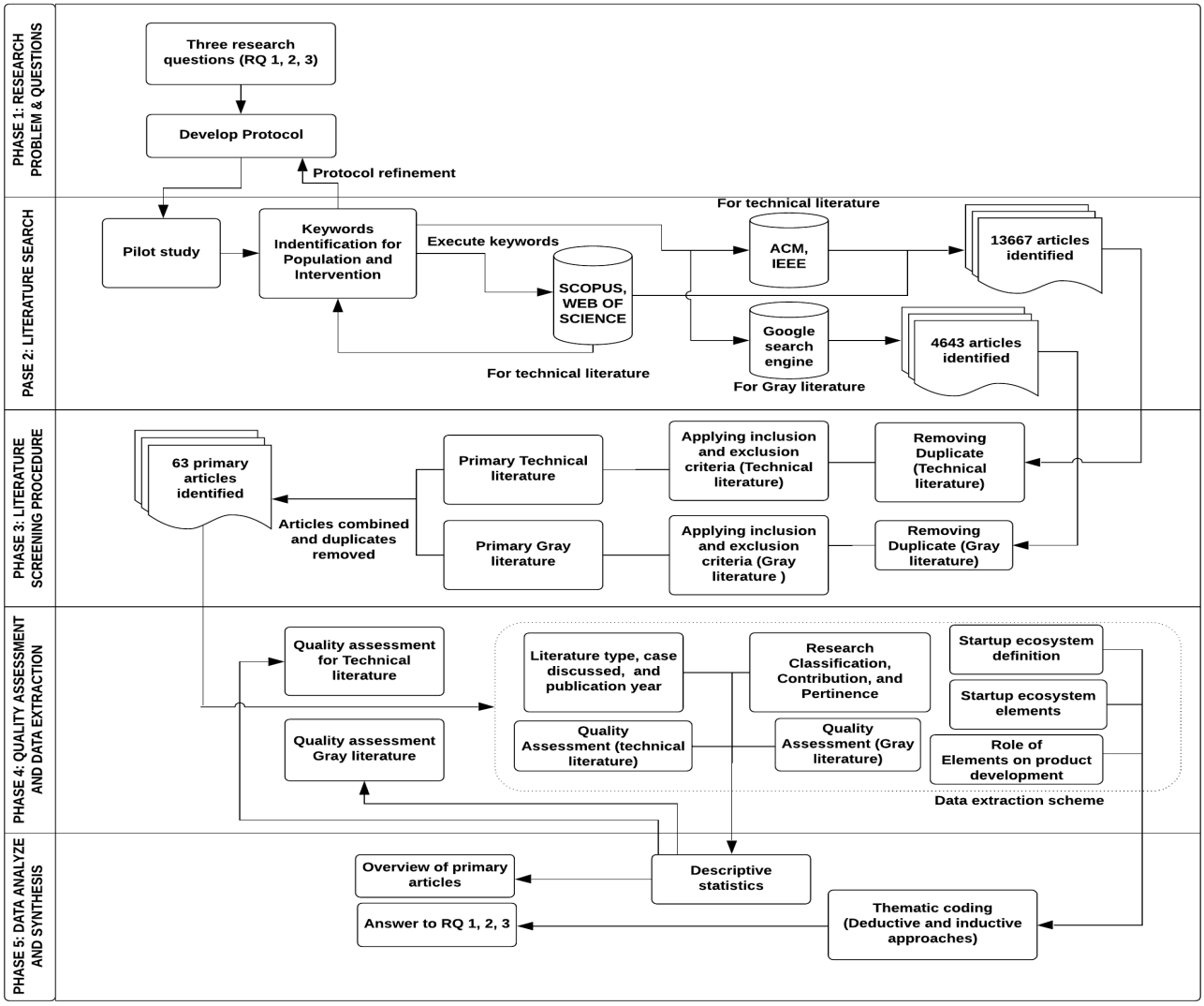


Figure 1: Overview of the research process

- ACM (a technical database)[3]
- IEEE (a technical database)[4]
- SCOPUS (a technical database)[5]
- WEB OF SCIENCE (a technical database)[6]

We used the START tool [7] to import and analyze the results from the electronic databases. We utilized this tool, designed for a systematic literature review, in our previous literature review [31].

With respect to Google's search engine, to make the search process for gray literature rigorous and thorough, we used the criteria described in a study [29], applied as follows:

- We erased our search history and cache in Chrome, as well as signed out from our personal Google accounts.
- We switched off Google instant predictions and set the page view to 100 results/links per page instead of 20.
- To import the results from the browser, we added the SEOQuake1 plugin[8].

In Google's search engine, the search string "population + intervention" was used; the results were imported into an Excel spreadsheet by using the SEOQuake1 plugin.

[3] http://dl.acm.org/
[4] http://ieeexplore.ieee.org/Xplore/home.jsp
[5] https://www.scopus.com/home.uri
[6] https://apps.webofknowledge.com
[7] http://lapes.dc.ufscar.br/resources-and-downloads/tools
[8] https://www.seoquake.com/index.html

### 3.3. Literature Screening Procedure (Phase 3)

Our search strategy produced an immense amount of articles (18,310) from two different data sources. To analyze the articles, we applied inclusion and exclusion criteria in the electronic databases and Google's search engine. Figure 2 presents an overview of the selection process. The inclusion and exclusion criteria for the articles retrieved from the electronic databases were applied in two phases. For the first phase, we focused on the title, the abstract, and the keywords, and we used the following inclusion (I) and exclusion (E) criteria:

- (E) The focus was not on startups and/or the startup ecosystem and did not contain aspects, such as software and technology.
- (E) The article was unavailable or was a letter or an editorial.
- (E) Non-English articles were excluded because analyzing their content would be difficult.
- (I) The keywords "population" and "intervention" appear in the title, the abstract, and the keyword list.

After the first phase, 35 articles that contained the keywords "population" and "intervention" in their title, the abstract, and the keyword list were found. In the second phase, we proceeded with full text reading to check whether each study described the state of some features of the startup ecosystem. After the full text reading, nine articles were included as primary study candidates from the electronic databases. We provide some examples of the articles [32, 33, 34] among 26 ones that were excluded after a full text reading. For example, one [32] was rejected because it did not discuss any specific startup ecosystem case, whereas two others [33, 34] were rejected because they discussed digital innovation ecosystems and mobile ecosystems, which were beyond the scope of our study. Similarly, the rest of the excluded articles were also out of scope.

The number of articles retrieved from Google's search engine totaled 4,643. To assess these articles, we used the following inclusion criteria:

- If the URL was available and its content was in English, the article was included.
- If the theme of the web page was a startup ecosystem and it had information on some real cases of a startup ecosystem and aspects of its technology, the article was included.
- Only text-based web pages were considered for inclusion. If a web page's major content comprised videos, audios, or images, it was excluded. Quora, Slideshare, and LinkedIn web pages were also excluded.

The duplicates found totaled 2,108. After applying the inclusion/exclusion criteria, we selected 57 articles. Two of the rejected articles included a literature review that did not provide primary information [23], as discussed in Section 2.3, and another that lacked enough information related to the topic [35].

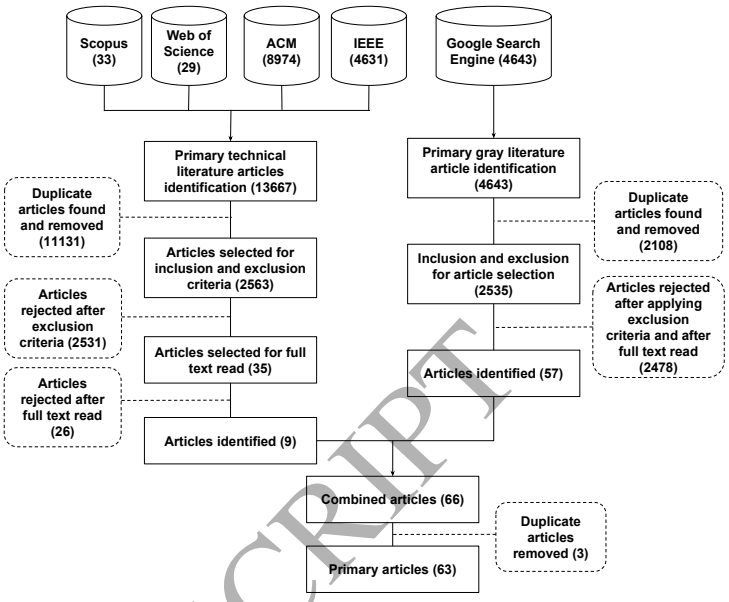


Figure 2: Search and article selection procedure

Some articles were found in both the electronic databases and Google's search engine (e.g., [32] in an electronic database, with copies found in Google's search engine, e.g., [36, 37]. Next, we combined the articles from the peer-reviewed and non-peer-reviewed literature and found three duplicates. Removing these duplicates resulted in 63 primary articles for quality assessment (QA) and for data extraction (DE) and synthesis. Appendix A presents detailed information on the primary articles.

### 3.4. Quality Assessment and Data Extraction (Phase 4)

To conduct the extraction, we used NVivo11 and Excel. Precodes were created to obtain an overview of the articles (DE 01–03) and the kind of research conducted on the topic (DE 04–06), as well as to conduct a QA of the articles (DE 07–08). The reason for doing this in Nvivo was that we wanted to keep the chain of evidence. Later on, the gathered information was stored in an Excel spreadsheet for statistical analysis. Similarly, precodes were created for DE 09 and 11, whereas postcodes were created for DE 10. The DE is discussed in detail below.

#### 3.4.1. Primary articles' properties (DE 01–06)

*Type of article (DE01).* During DE, we classified the primary articles based on three types: peer-reviewed technical articles; white papers issued by the government, local authorities, or other reliable sources that describe or discuss startup ecosystems; and Internet articles that are opinion papers published on web pages by various writers.

*Publication year (DE02).* Articles' publication dates were obtained, and the articles were arranged according to their respective publication years.

*Regional and national cases (DE03).* The cases discussed in the primary articles were extracted with respect to their country of origin.

*Research classification (DE04).* To evaluate the type of research conducted in the primary articles, we used the following categories, as discussed in [38]:

- Evaluation: provides novel knowledge with the use of a proper research method
- Solution proposal: provides a solution (novel) without giving a proper validation of the proposed solution
- Philosophical: provides a new concept or a model to offer new perspectives on certain aspects
- Opinion: incorporates the author's opinions on certain aspects
- Experience: reflects the author's own experiences in certain aspects, learned from the previous work
- Validation: validates the various features of a solution, which has not been implemented earlier with a suitable method

However, the retrieved articles match only five categories (evaluation, solution, validation, opinion, and experience).

*Research contribution type (DE05).* Next, we analyzed the primary articles' types of contributions by using Shaw's [39] proposed categories, which are as follows:

- Procedure or technique: a new kind of technique that can help researchers perform some tasks effectively
- Qualitative or descriptive model: classification and formulation of a research problem or the construction of a framework and a model with a proper explanation of interesting phenomena
- Empirical model: a model or a framework based on empirical or observed data collected for evidence
- Analytic model: usually a model that uses a formal or a mathematical analysis
- Specific solution: a solution to a given problem in the area of, for example, software engineering
- Report: reflections on the observed phenomena

*Pertinence aspect (DE06).* We also examined the pertinence aspect of the articles by classifying them as full, partial, or marginal, which are described as follows:

- Full: fully focuses on startup ecosystems
- Partial: presents knowledge and discusses the startup ecosystem but does not focus fully on it
- Marginal: minor or very limited focus on the startup ecosystem

*3.4.2. Primary articles' quality assessment (DE 07–08)*

QA is an important aspect of a systematic literature review in order to evaluate the value and the credibility of the primary candidate articles in the context of our RQs. We performed the QA, along with the extraction of general information from the primary studies. To assess quality, we applied two separate approaches, and the first and the second researchers jointly performed the QA.

*Technical articles.* For technical articles, we used a proposed framework [40], in which articles were evaluated based on their research rigor and industry relevance. To evaluate research rigor, we considered three aspects—context description, study design, and study validity—by using the following criteria with the corresponding points: weak (0), medium (0.5), and strong (1).

- Context description: The objective is to analyze whether the context is properly discussed in the study.
- Study design: The article describes the proper study design to give a clear overview of the variables used in the study.
- Study validity: The study's validity is described in the article, including the potential threats to it.

To evaluate industry relevance, we considered the following criteria: subject, context, scale, and research method. If an aspect was relevant to the industry, an article scored 1 point; otherwise, it earned none (0). Later, we summed up the points earned by an article in these different aspects, and we obtained the total value in terms of rigor and relevance.

- Subjects: Analyze what kinds of subjects were involved in the study in terms of practitioners, students, and researchers
- Context: Examine the context (industry or laboratory environment) of the study
- Scale: Evaluate the study by considering its applications on a realistic scale
- Research method: Use a research method that can help evaluate the real situation and is useful for practitioners

*Gray literature.* With respect to the gray literature, such as white papers and Internet articles, we used the same criteria as those used in a study [41], and these are discussed as follows:

- Position and certainty of the article: The article found from the search engine is examined, and its reliability is evaluated. An article from a government website's link is given the highest ranking.
- Clarity: The clarity of the article's content is evaluated.
- Detail: The article's content with respect to detailed knowledge of startup ecosystems is evaluated.

- Consistency: The article's consistency and references are evaluated.
- Alignment with the research focus: The alignment of the article's focus with the focus of the present research is evaluated.

These aspects are evaluated and rated as low (0), medium, (0.5), or high (1). Finally, the total value is calculated by adding the values of all five aspects.

#### *3.4.3. Answers to research questions 1, 2, and 3*

The following aspects were identified to answer our RQs:

*Definition of a startup ecosystem (DE 09) and (RQ1).* Information on a startup ecosystem's definition is extracted from primary articles to answer the first RQ.

*Elements of a startup ecosystem (DE 10) and (RQ2).* For the second RQ, we used the inductive approach in which postcodes were formed by extracting the data from each article and then labelling these for further comparison in order to identify themes.

*Role in product development (DE 11) and (RQ3).* Data from the articles highlighting the role of different elements in product development stages (concept, in development, working prototype, functional product with limited users, functional product with high growth, and mature product) were extracted.

### *3.5. Data Analysis and Synthesis (Phase 5)*

The gathered information, which consisted of article type, publication year, research classification, contribution, pertinence, and QA of technical articles and gray literature, as stored in an Excel spreadsheet, was statistically analyzed in terms of frequencies. For DE 09, 10, and 11, we applied the thematic analysis strategy [42] to extract, analyze, and interpret the data. We used the deductive approach for DE in the form of precodes for DE 09 and 11. For example, the precode for DE 09 was set as "startup ecosystem definition" and the following text (from [P47]): "A startup ecosystem includes the array of stakeholders, and the support infrastructure they provide, which is made available within the given region for the support of those starting a new business.", which was highlighting regarding startup ecosystem description was fetched and assigned to the pre codes DE 09.

The inductive approach in the form of postcodes was used for DE 10. In this, postcodes were formed by extracting the data from each article and then labelling them for further comparison. We constantly compared the codes with one another until themes emerged. Initially, we obtained 109 labels; after comparing them, we ended up with 35 codes. These codes were further compared, resulting in eight themes. An example of this can be seen in Table 4 for the "finance" theme, in which codes, such as funding, established companies, seed investment, venture capital, bank, crowd funding, and government, point toward the importance of funding in startup creations and how these codes play a role in it.

Some of the codes were common in a few themes. For example, the codes "incubators" and "accelerators" acted as the key sub-elements in "supporting factor," but they also have a key part in "education." For instance, a line in an extracted text [P22] states, "That's where the value of mentorship and training offered by accelerators in areas such as staying lean and agile, developing clear product-market fit, viable business models, and accessing customers and capital becomes clear." The text can be interpreted as the characteristics of accelerators in supporting startups, but it also signifies accelerators' role in education. Likewise, the code "established companies" helped in the theme "finance," which means that financial assistance is given to startups; however, it also supports the "technology" aspect in the startup ecosystem by providing startups with the platform and tools to develop products. Additionally, to avoid any bias during the DE and synthesis, we ensured that the first and the third researchers worked together during the deductive and inductive approaches, whereas the second researcher double-checked the DE and the thematic synthesis.

## 4. Results

From the systematic review, 63 primary studies were found relevant to our RQs. Our analysis also revealed that software-intensive product startups were dominating the startup ecosystem phenomenon. Table 2 and Appendixes A and B present the descriptions of the primary articles. In the following subsection, we give an overview of the primary studies. We then explore the definitions of the startup ecosystems, and current research on them. Next, we examine the elements of the startup ecosystem and then analyze their role during product development.

### *4.1. Overview of Primary Articles*

An overview of the primary studies is discussed under the following categories:

*Type of article.* The primary studies include technical articles, white papers, and Internet articles published from 2000 to 2016. Figure 3b and Table 2 show an overview of the articles by type. Out of the 63 articles, 17% are technical articles, 27% are white papers, and the rest (56%) are Internet articles (Figure 3b). The conclusion derived from the figure is that technical articles regarding the startup ecosystem are few, and most of the knowledge on the topic is contributed by gray literature.

*Publication year.* Analysis of the publication frequency throughout the period under study offers another insight into the topic. As shown in Figure 3c, from 2000 to 2011, only three articles were found. From 2012 to 2013, the number increased to 10 articles, especially Internet articles discussing the startup ecosystem. From 2013 to 2016, there was a continuous increase in interest on the topic. We identified a steady increase in the number of publications classified under the three article types. In 2016, 16 articles were found; it should also be considered that we ended our search in August 2016. The most remarkable observation from the above findings is the gradually growing

Table 2: Primary articles' details

| ID | Year | Article Type | Classification | Contribution | QA | ID | Year | Article Type | Classification | Contribution | QA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [P1] | 2000 | White Paper | Opinion | Qualitative | 2.5/5 | [P2] | 2015 | Internet Article | Opinion | Report | 3/5 |
| [P3] | 2008 | Technical | Validation | Qualitative | 5/7 | [P4] | 2015 | Internet Article | Opinion | Report | 3/5 |
| [P5] | 2011 | Technical | Solution | Empirical | 4/7 | [P6] | 2015 | Internet Article | Opinion | Report | 3/5 |
| [P7] | 2012 | Internet Article | Opinion | Report | 3.5/5 | [P8] | 2015 | Internet Article | Opinion | Report | 4/5 |
| [P9] | 2012 | Internet Article | Opinion | Report | 3/5 | [P10] | 2015 | Internet Article | Opinion | Report | 2.5/5 |
| [P11] | 2012 | Internet Article | Opinion | Report | 3/5 | [P12] | 2015 | Internet Article | Opinion | Report | 3.5/5 |
| [P13] | 2012 | Internet Article | Opinion | Report | 3/5 | [P14] | 2015 | Internet Article | Opinion | Report | 2.5/5 |
| [P15] | 2012 | White Paper | Experience | Report | 5/5 | [P16] | 2015 | Internet Article | Opinion | Report | 3/5 |
| [P17] | 2012 | Technical | Evaluation | Qualitative | 3.5/7 | [P18] | 2015 | Technical | Solution | Procedure | 5/7 |
| [P19] | 2012 | Technical | Experience | Empirical | 5.5/7 | [P20] | 2015 | White Paper | Evaluation | Qualitative | 5/5 |
| [P21] | 2013 | Internet Article | Opinion | Report | 3/5 | [P22] | 2015 | White Paper | Experience | Report | 5/5 |
| [P23] | 2013 | Internet Article | Opinion | Report | 3/5 | [P24] | 2015 | White Paper | Experience | Report | 5/5 |
| [P25] | 2013 | White Paper | Evaluation | Qualitative | 5/5 | [P26] | 2015 | White Paper | Evaluation | Qualitative | 5/5 |
| [P27] | 2014 | Internet Article | Opinion | Report | 3.5/5 | [P28] | 2015 | White Paper | Experience | Empirical | 5/5 |
| [P29] | 2014 | Internet Article | Opinion | Report | 3.5/5 | [P30] | 2015 | Technical | Solution | Qualitative | 3/7 |
| [P31] | 2014 | Internet Article | Opinion | Report | 1.5/5 | [P32] | 2016 | Internet Article | Opinion | Report | 4.5/5 |
| [P33] | 2014 | Internet Article | Opinion | Report | 2.5/5 | [P34] | 2016 | Internet Article | Experience | Report | 2.5/5 |
| [P35] | 2014 | Internet Article | Opinion | Report | 3/5 | [P36] | 2016 | Internet Article | Opinion | Report | 3.5/5 |
| [P37] | 2014 | Internet Article | Opinion | Report | 2.5/5 | [P38] | 2016 | Internet Article | Experience | Report | 3/5 |
| [P39] | 2014 | Internet Article | Opinion | Report | 2.5/5 | [P40] | 2016 | Internet Article | Opinion | Report | 2.5/5 |
| [P41] | 2014 | Technical | Evaluation | Empirical | 6/7 | [P42] | 2016 | Internet Article | Opinion | Report | 3/5 |
| [P43] | 2014 | White Paper | Evaluation | Empirical | 5/5 | [P44] | 2016 | Internet Article | Opinion | Report | 3/5 |
| [P45] | 2014 | White Paper | Experience | Report | 4.5/5 | [P46] | 2016 | Internet Article | Opinion | Report | 4/5 |
| [P47] | 2014 | White Paper | Experience | Report | 5/5 | [P48] | 2016 | Technical | Evaluation | Empirical | 6/7 |
| [P49] | 2014 | Technical | Evaluation | Empirical | 5/7 | [P50] | 2016 | Technical | Solution | Empirical | 4/7 |
| [P51] | 2014 | White Paper | Opinion | Qualitative | 4.5/5 | [P52] | 2016 | White Paper | Experience | Report | 2/5 |
| [P53] | 2015 | Internet Article | Opinion | Report | 3/5 | [P54] | 2016 | White Paper | Experience | Report | 4/5 |
| [P55] | 2015 | Internet Article | Opinion | Report | 2.5/5 | [P56] | 2016 | White Paper | Evaluation | Qualitative | 4.5/5 |
| [P57] | 2015 | Internet Article | Opinion | Report | 2.5/5 | [P58] | 2016 | White Paper | Evaluation | Qualitative | 4.5/5 |
| [P59] | 2015 | Internet Article | Opinion | Report | 3/5 | [P60] | 2016 | White Paper | Experience | Report | 5/5 |
| [P61] | 2015 | Internet Article | Experience | Report | 3/5 | [P62] | 2016 | Technical | Solution | Empirical | 6/7 |
| [P63] | 2015 | Internet Article | Opinion | Report | 4/5 | | | | | | |

interest in the topic, which is expected to increase further in the coming years.

*Regional and national cases.* The most striking aspect to emerge from the primary articles involves the number of regional and national cases across the globe. Figure 3a illustrates the number of cases found with their reference identification numbers from [P1] to [P63]. For example, [P58] mainly focuses on Hong Kong's startup ecosystem, but it also discusses the cases of Chile, Malaysia, London, and Singapore for comparison purposes. Similarly, [P52[ gives examples of the startup ecosystem elements in Southeast Asian countries (Brunei, Cambodia, Indonesia, etc.). Figure 3a shows that the majority of the cases are from Europe, the US, Australia, and Southeast Asia. By contrast, relatively few cases are reported from South America, Africa, Mediterranean countries, India, South Korea, and Japan.

### 4.2. Current State of Research on Startup Ecosystems

Having given an overview of relevant studies in the previous section, in the current section, we discuss the current research situation, as observed from the primary studies on the startup ecosystem, classified under the following types:

*Research classification and contribution.* In terms of research classification, Table 2 and Figure 4 provide more information. Figure 4 shows that the opinion category has the highest number of articles (34), followed by experience (13) and evaluation (9). The large number of opinion articles is due to the huge amount of gray literature found in the review. Similarly, in terms of research contribution, Table 2 and Figure 4 present the results. Figure 4 shows that the largest number of articles (43 articles or over 50% of the primary articles) are under the report category, followed by the qualitative/descriptive model (10 articles) and the empirical model (nine articles). Only one article falls into the category of a procedure/technique. No article belongs to any of the following three categories: analytic model, tool, and specific solution.

*Pertinence aspect.* We also examined the pertinence aspect of the articles by classifying them as full, partial, or marginal. In this regard, 36 articles belong to the full category, comprising over 50% of the primary articles. Around 24 articles fall under the partial category, and the rest (three) are classified as marginal. The reason for such a high number of fully pertinent articles is the concrete content of gray literature on the startup ecosystem, especially the real-life cases discussed in these papers. Figure 4 and Appendix B provide more information.

### 4.3. Primary Articles' Quality

Figure 5 provides an overview of the QA for technical articles (top), as well as for white papers and Internet articles (bottom). Table 2 lists the total points given to each article. As shown in Figure 5 (top), most of the technical articles had high relevance; seven of the 11 technical articles had high relevance. However, only four articles had a total value of 2 points or more in terms of research rigor. In addition, the rest of the articles' rigor levels were below 1.5 points. We determined that those articles with high relevance were suitable candidates to help address the RQs. However, this result also indicates that further research on the startup ecosystem with higher rigor is required.

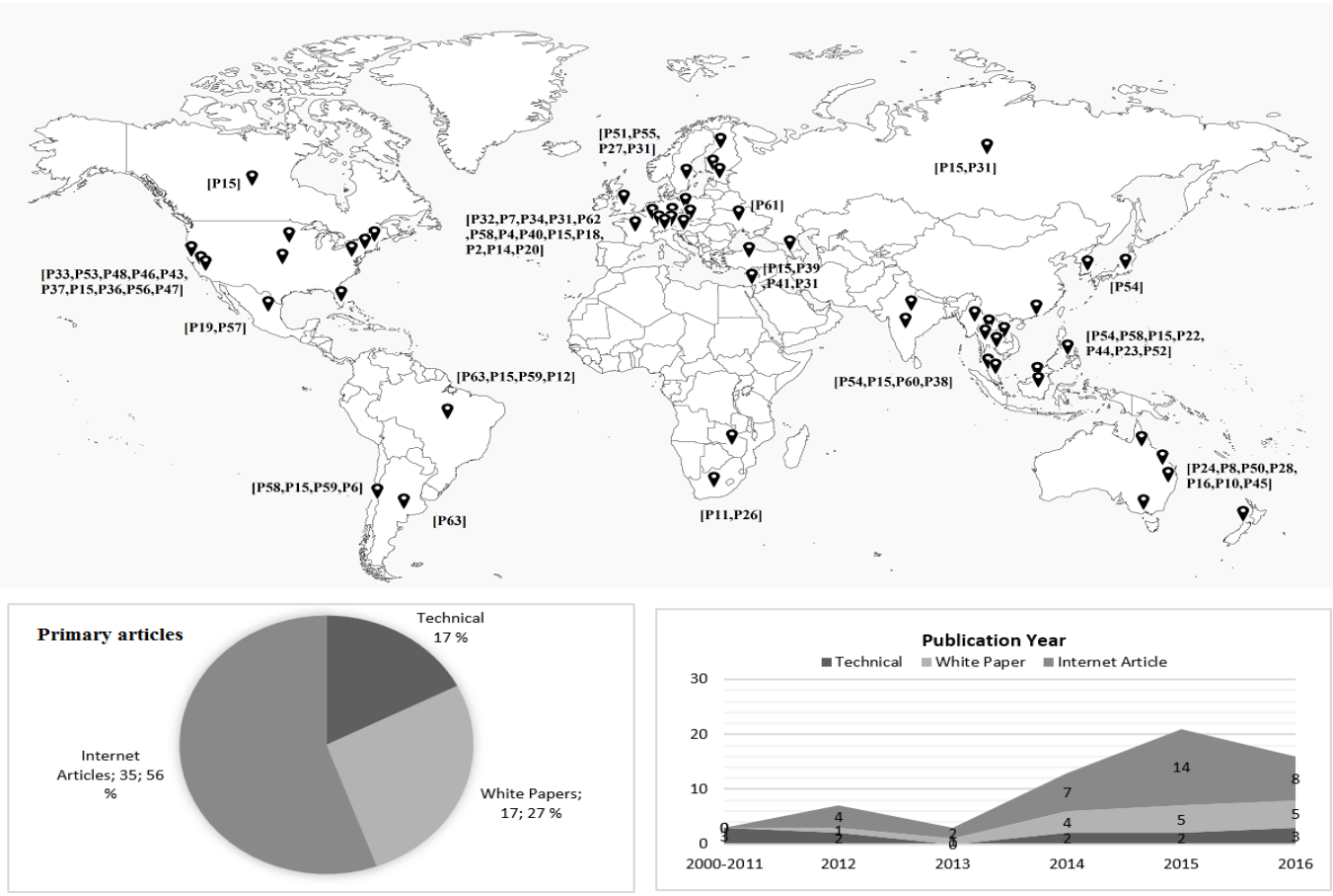


Figure 3: (a) Top: regional and national cases, (b) Bottom left: articles' percentages and types, (c) Bottom right: publication year

In case of white papers and Internet articles, as illustrated in Figure 5 (bottom), more than 50% of the articles belonged to the medium category in terms of position and certainty of the article (32 articles), clarity (33 articles), detail (36 articles), and consistency (34 articles). However, 38 articles (falling either into the strong and medium categories in the earlier aspects) strongly aligned with the research focus, giving us an adequate basis for answering our RQs.

### 4.4. RQ 1. Definition of a Startup Ecosystem

One of the objectives of this literature review is to find definitions of the startup ecosystem in the existing literature, which we explore through the first RQ. Out of 63 primary articles, four articles explicitly describe a startup ecosystem. Explaining correctly what the term means is crucial. In their case study of New York City, Cukier et al. [P48] defined a startup ecosystem as follows:

"a limited region within 30 miles (or one-hour travel) range, formed by people, their startups, and various types of supporting organizations, interacting as a complex system to create new startup companies and evolve the existing ones." [P48]

From this definition, we can determine that a startup ecosystem focuses on a particular region where entrepreneurs and supporting organizations collaborate to create new startups and drive the existing ones. Similarly, Cervantes and Nardi [P19] described the establishment of a startup culture in a Mexican region and presented their perspective on a startup ecosystem:

"The startup community uses the term "ecosystem" to refer to the network of people, institutions, and resources needed to build startups. This ecosystem includes entrepreneurs from different backgrounds, skills, and levels of experience, as well as private investors, public and private funding institutions, large companies that create infrastructure, and universities." [P19]

In the preceding description, the word "ecosystem" in "startup ecosystem" denotes a network of people, organizations, and resources required to create startups. In terms of people, the cited authors refer to entrepreneurs, as well as investors. With respect to organizations, they mention funding institutions, large companies, and universities, which provide the resources to create an infrastructure for supporting the creation of startups. In another article [P47], a startup ecosystem is defined as follows:

"A startup ecosystem includes the array of stakeholders, and the support infrastructure they provide, which is made available within the given region for the support of those starting a new business." [P47]

It means that in a region, an ecosystem comprises several stakeholders aiming to provide supporting infrastructure in or-

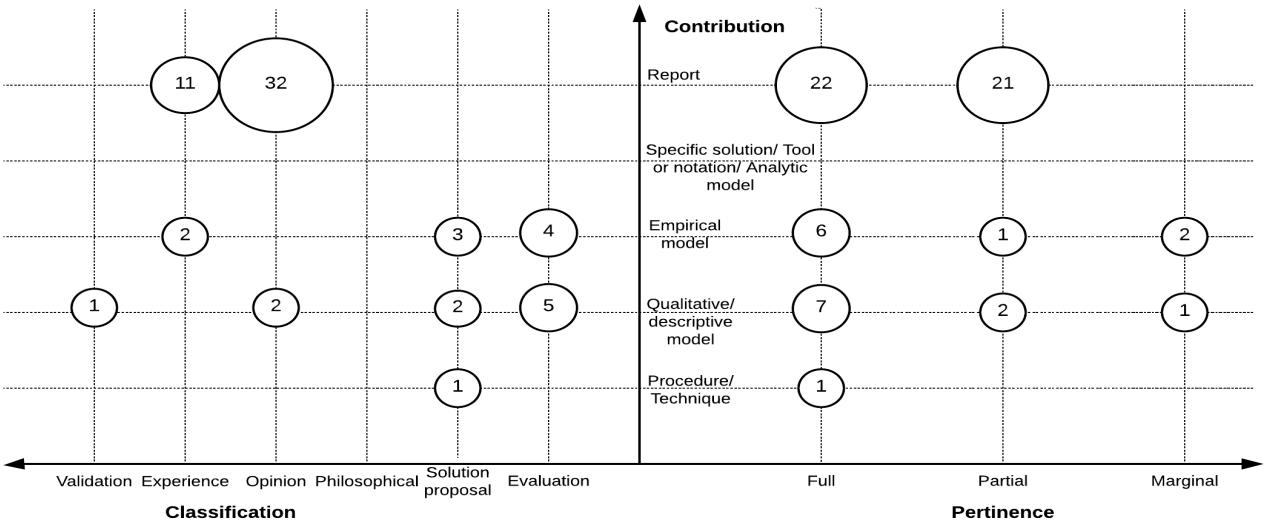


Figure 4: Research classification, contribution, and pertinence

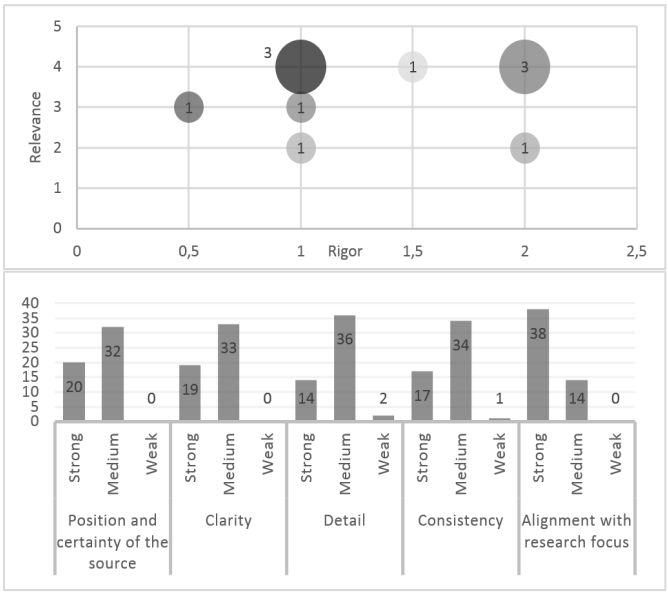


Figure 5: Quality assessment (rigor and relevance) of technical articles (top), quality assessment of white papers and online articles (bottom)

der to create new ventures. Likewise, Krajcik and Formanek [P18] discussed the context of a startup ecosystem from a regional perspective, in which it is considered a method. A country perspective also reflects an ecosystem's benefits and importance. This view is supported by previous studies [P47 and P48] that explained an ecosystem from a regional perspective, in which people try to support both new and existing startups. Krajcik and Formanek in [P18] described it as follows:

"A regional startup ecosystem is an effective method to endorse regional innovations and the development of the business environment along with securing the growth of the domestic product and employment in the given country." [P18]

From the above observation, it appears that four descriptions of a startup ecosystem overlap with one another to a certain extent. However, some variation also exists among them. We therefore took an inclusive approach to analyze the definitions by using the criteria discussed in [43] in order to achieve a common representation of a startup ecosystem. The rationale behind our approach is that a startup ecosystem is a multidimensional phenomenon; furthermore, the definitions provided in the articles were based on based on different study contexts (e.g., [P48] in New York City and [P19] in different Mexican regions). The analyses of these definitions, by considering the criteria mentioned in [43], are as follows:

*Environment.* For a startup ecosystem, its environment could be a local or a particular region, for example, "a regional startup ecosystem" [P18] or "within the given region" [P47]. The region could be within a 30-mile radius, as indicated in [P48]: a "limited region within 30 miles (or one-hour travel) range."

*Actors.* The actors can be stakeholders ("includes the array of stakeholders" [P47]), which are also in the form of supporting organizations, for instance, ("various types of supporting organizations" [P48]) performing supporting roles, whereas the startups themselves form the core of the ecosystem. Supporting roles are played, among others, by educational institutions, governmental and local authorities, and some types of funding bodies ("private investors, public and private funding institutions, large companies that create infrastructure, and universities" [P19]). Large companies or actors offering venture capital (VC) may play the role of stakeholders.

*Implication on a smaller scale.* The implication of a startup ecosystem on a small scale would be the creation of new businesses or startup companies, such as to "create new startup

companies and evolve the existing ones," as described in [P48]; to "build startups," as stated in [P19]; or to "start a new business," as indicated in [P47].

*Implication on a larger scale.* On a larger scale, a startup ecosystem could have an impact on the increased production of domestic products, as well as on the creation of jobs in a particular region or country. As stated in [P18], a startup ecosystem contributes to the "growth of the domestic product and employment in the given country."

*Important factors that play roles in ecosystem growth.* The factors that could influence the growth of an ecosystem are the interactions among stakeholders, as well as the available skills and talents in a particular region. For example, some articles mention "interacting as a complex system" [P48], a "network of people, institutions, and resources" [P19], and "entrepreneurs from different backgrounds, skills, and levels of experience" [P19], as well as contributing to an increase in employment and economic growth.

In summary, some differences appear in all four definitions. For example, [P48], [P47], and [P18] discuss startup ecosystems in a regional perspective, but this is not the case in [P19]. Similarly, [P47] and [P18] pinpoint that a startup ecosystem is important for economic development, whereas [P48] and [P19] stress more on the creation of startups. Therefore, considering the four definitions and analyzing them with the criteria in [43], we came to the conclusion that a startup ecosystem operates in the environment of a specific region. It involves actors that can act as stakeholders, such as entrepreneurs, investors, and other groups of people who have some self-interest in the ecosystem. They collaborate with supporting organizations, such as funding agencies, governments, and educational institutions. They establish organizations to create an infrastructure in which a common network that could support and build startups on a smaller scale is set up, as well as to increase domestic product development and the creation of new jobs in the country on a larger scale.

### 4.5. RQ 2. Elements of a Startup Ecosystem

In this section, we highlight the elements of a startup ecosystem (at the abstract level), as discussed in the literature. These are shown in Table 3. Next, we describe the elements that we found through our thematic analysis of the literature (Table 4). A closer examination of the elements given in [P41], [P45], and [P50] (Table 3) shows several similarities and differences among them. For example, *culture* appears in all three articles, yet they differ in some elements (e.g., *market* appears to be a key element only in [P41], *technical skills* appears only in [P45], and *physical space and events* seem to be key elements only in [P50]). In addition, all three articles lack a full picture in the global context. For example, [P41] provided elements based on its study in three cities of Israel, [P45] proposed elements based on a few studies and a general assumption on the topic, and [P50] suggested elements based on previous models and its own understanding of the subject. These distinctions indicate the need to explore and understand the various elements

Table 3: Elements discussed in the articles (higher level)

| Reference | Elements in a Startup Ecosystem |
|---|---|
| [P41] | Entrepreneur, Funding bodies, Legal frame, Market, Incubator/Accelerator, University/Research Center, Education, Demographics, Geography Politics, Family, Culture, Society, Technologies, Methodologies, Established Company |
| [P45] | Entrepreneurship culture, Experienced mentors, Regulatory environment, Collaborative culture, Visible successes, Risk tolerance, Availability of capital, Technical skills |
| [P50] | Culture, Champion, Network, Stakeholder engagement (local, state, and federal governments; service providers (e.g., accountants, lawyers, and consultants); educational and research institutions; mentors; investors; media; entrepreneurs), Process, Physical space, and events |

of a startup ecosystem that are described in all the primary studies and to create a general view of the elements that constitute a startup ecosystem.


Figure 6: Word cloud of the top 50 words in primary papers

To create a general view on the topic, we subjected all primary articles to a word frequency query and thematic analysis using an inductive approach (see Section 3.5) in NVivo. Figure 6 presents the results of the word frequency query. In the thematic analysis, we found eight major themes as the main elements that are important in a startup ecosystem. These major themes are derived from the sub-elements of the main ones, which are listed in Table 4 and discussed in the following subsections:

#### 4.5.1. Entrepreneur

The first and most important element in the startup ecosystem is the entrepreneur, referring to anyone who wants to start a new business venture. Entrepreneurship can be categorized as based on need, often relating to self-employment and an opportunity-based enterprise [P45]. In India, technology entrepreneurs aim to build startups that will attract investors worldwide and will be scaled in the form of unicorns [P22, P60]. Startups that have a value equal to and over $1 billion, as evaluated by a VC firm, are called unicorns [44]. Entrepreneurs are usually mentored by

Table 4: Elements and sub-elements of a startup ecosystem

| Element | Sub-element | Articles |
|---|---|---|
| Entrepreneur | Entrepreneur | [P7, P40, P25, P15, P22, P11, P56, P27, P60, P45, P31] |
| Support factors | Incubators | [P32, P54, P13, P28, P29, P14, P26, P52, P34, P45, P7, P46, P35, P42, P41, P21, P27, P9] |
| | Accelerators | [P54, P24, P41, P36, P21, P27, P9, P26, P52, P34, P6, P45, P53, P12, P25, P58, P8, P61, P39, P22, P44, P42] |
| | Co-working space | [P54, P7, P28, P29, P14, P52, P34, P31, P19, P53, P35, P50, P42, P56, P27, P13] |
| | Events | [P32, P54, P42, P41, P27-P29, P52, P12, P19, P53, P58, P48, P46, P35, P61, P50] |
| | Government | [P32, P54, P44, P59, P11, P36, P56, P55, P60, P26, P38, P52, P24, P6, P57, P45, P31, P12, P47, P25, P7, P53, P58, P48, P50, P40, P39] |
| | Legal framework | [P24, P42, P41, P6, P47] |
| | Media | [P35, P39, P27, P38, P12] |
| | Mentors | [P50, P44, P41, P56, P13, P45] |
| Finance | Funding | [P32, P33, P4, P50, P40, P15, P22, P42, P41, P56, P18, P27, P54, P13, P28, P14, P26, P20, P6, P57, P45, P31, P47, P24, P25, P7, P53, P58, P48, P46, P43] |
| | Established companies | [P56, P55, P27, P60] |
| | Seed investment | [P24, P53, P28, P26, P20, P6, P45, P25, P58, P48, P4, P40, P42, P41, P56, P13] |
| | Venture capital | [P33, P54, P45, P25, P24, P58, P4, P22, P41, P56, P26, P20] |
| | Bank | [P46, P14, P20] |
| | Crowd funding | [P24, P4, P28, P20, P34] |
| | Government | [P24, P7, P4, P41, P28, P26, P45] |
| Demographic | Cultural & language | [P54, P24, P31, P58, P48, P50, P40, P42, P59, P41, P28] |
| | Gross domestic product | [P7, P19, P40, P22, P42] |
| | Geography | [P24, P58, P52, P45, P47, P51, P37, P50, P40, P15, P39, P42, P41] |
| | History | [P33, P48, P51, P39, P36, P60, P12] |
| | Society | [P58, P38, P47] |
| | Immigrants | [P54, P48, P41, P56, P31] |
| Market | Market | [P32, P24, P38, P20, P31, P25, P7, P58, P17, P61, P15, P27, P9, P28] |
| | Local market | [P58, P41, P31] |
| | Global market | [P58, P41, P31] |
| | Customer | [P58, P38, P20] |
| | Economic | [P7, P15, P38] |
| Education | Education | [P24, P35, P17, P55, P28, P26, P20, P10, P45] |
| | Educational institution | [P24, P41, P9, P1, P13, P14, P26, P31, P12, P62] |
| | Accelerator & incubator | [P48, P21, P13] |
| | Experience | [P41, P45] |
| | Media | [P19, P50] |
| | Family | [P41] |
| Human Capital | Talent | [P24, P43, P56, P2, P28, P10, P57, P47] |
| | Education | [P24, P58, P43, P41, P9, P13, P28, P26] |
| | Accelerator & incubator | [P43, P44, P13] |
| | Experience | [P41, P13] |
| | Government | [P24, P7, P31, P58, P51, P43, P15, P22, P42, P36, P57] |
| | Young talent | [P58, P43] |
| | Policy | [P58, P15, P41, P45] |
| Technology | Technology | [P33, P24, P28, P60, P26, P38, P20, P58, P8, P17, P50, P39, P56, P2, P9] |
| | Education | [P24, P5, P17, P44, P55, P1, P57, P45, P31, P12] |
| | Established companies | [P54, P58, P8, P61, P40, P36, P55, P27, P34, P25] |
| | Founders | [P17, P41, P20] |
| | Industry | [P54, P24, P58, P37, P22, P31, P47] |
| | Geography | [P54, P58, P50, P39, P29, P52] |
| | Innovation | [P33, P50, P55, P14, P20, P47] |
| | Product | [P41, P20] |

incubators and accelerators, who can help develop a business model and establish a startup. Mindset is also an important aspect that shapes entrepreneurs. A startup operating with a too optimistic approach will result in a short lifespan, and its market entry will be difficult [P20]. Such a strategy best serves large companies and is appropriate for products targeted at the global market. By contrast, realistic startups undergo moderate development and exert less influence on investors [P20].

#### *4.5.2. Support Factors*

The second major theme, support factors incorporate many sub-elements, which are unique and important for the startup ecosystem context with respect to providing support. We discuss support factors second because their sub-elements also contribute to the other main elements in the startup ecosystem. The following sub-elements act as support factors in the startup ecosystem:

*Incubators.* During the early stages of startups, the role of incubators is crucial. They conduct programs on a particular location to attract talent by providing mentorship to founders and entrepreneurs [P13, P14, and P21]. During the incubation period of startups, incubators work together with other entities, such as mentors, in a co-working space, with the objective of providing entrepreneurs with the opportunity to transform their ideas into a real growing startup [P14, P29]. Incubators can obtain support from both public (e.g., government funding) and private sectors [P28, P34]. In these programs, professionals, such as designers and developers, as well as companies and entrepreneurs, aim to create business cases, develop products, and receive feedback on their business ideas [P14, P42]. Serial entrepreneurs sometimes operate incubator programs, with the aim of helping individuals and teams that are interested in creating startups [P27].

*Accelerators.* After incubators provide support, if the founders have developed a startup that has an inventive business idea and a business potential to disrupt the existing market, they require advanced support, that is, further funding and intensive mentorship to accelerate their business. This step is done by accelerators, who provide further mentorship through the accelerator programs in a working space [P21, P22, P54]. Mentorship could include sharing of knowledge on lean and agile methods, the development of a product–market fit, the creation of an applicable business plan, and customer networking [P22]. An accelerator program is described by [P24] as "a structured program to help innovative early-stage companies swiftly come to market." Accelerator programs (usually about 3–6 months in duration) can help in removing the hurdles during a startup's growth stage by providing entrepreneurs with the necessary mentorship and early-stage funding [P22, P24]. Sometimes, if venture capitalists do not exist in a region, accelerators can take their place by turning into investors [P53].

*Co-working space.* A co-working space, also referred to as a studio [P34] or a laboratory [P35], is a spot where interested entities, such as incubators, venture capitalists, and others, collaborate (sometimes in a single building) to support founders and

entrepreneurs in developing startups and creating innovative projects [P13]. Having a principal location for work, meetings, and collaboration is key to nurturing startups [P22, P28]. The objective of a co-working space is to provide a cost-effective workspace for startups, which could enable the sharing of the required information and culture that motivate startups to take risks [P19, P50].

*Events.* Events are created and organized to find co-founders, talented individuals, and investors, and it is also where startups can give their pitch to attract investors' attention [P12]. Events can act as a catalyst for the creation of startups and an innovation culture in a region [P19, P50]. During an event, entrepreneurs can meet face to face, discuss their problems, and share innovative methods [P19]. For example, in Tokyo, events aim to establish opportunities for Japanese people to network with foreign startup founders, whereas the startup weekend has been initiated in Mexico to provide high-quality entrepreneurship education for entrepreneurs [P19, P54]. Similarly, in Finland, Slush (Europe's leading startup event) is organized each year [P27 and P61].

*Government.* A key support factor is the government. The government's responsibility includes the creation of an environment that is conducive for the growth of startups and new businesses in a region, which can drive investors to invest in the region [P26]. Governments create programs in which they collaborate with other organizations so that their support can reach startups. For example, some governments collaborate with incubators by providing funds to incubator programs that can offer mentoring to startups [P59]. Examples of government support are highlighted in the literature; for instance, [P54] mentioned that the government in India is hugely investing in startup creation, whereas [P12] reported that the government in Brazil is attempting to enhance the regional ecosystem by giving grants to startups and private accelerators. In the case of Hong Kong, the government improved legal procedures to make these conducive for startups [P58]. In Finland, the government is cooperating with large companies, such as Nokia, to support both local and foreign startups [P55].

*Legal framework.* When choosing the potential market region for its product, a startup should consider the legal aspects in that region, which could be in the form of taxes, intellectual property rights, and the level of bureaucratic intervention [P41]. The legal framework should also be conducive to immigration because immigrant entrepreneurs have the potential to create new businesses that would result in job creation in the region and maintain the region's competitiveness in the global market [P45]. Additionally, a fast-growing startup often shifts from its local place to other places, such as Silicon Valley, where the legal framework is beneficial for startups. This relocation can lead to negative results for the local region in terms of cash and human capital losses. Hence, having a legal framework that is conducive for startups is vital for a region [P6].

*Media.* The use of media, such as social media (e.g., Twitter, Instagram, and Facebook), can help in creating awareness and generating interest in a startup's product or its events [P39]. Another usage could be to gain free publicity [P38]. News agencies are eager to know and publish about innovative startups that have unique products or business ideas [P27]. Blogs are also used as a medium and are common among startups to reach potential users and customers [P12].

*Mentor.* During incubator and accelerator programs, the role of mentorship comes into play. The type of mentor involved is critical, especially for early-stage founders and startup teams that have reached a later stage of development [P44]. A mentor has the potential to create an entrepreneurship mindset in the ecosystem [P50]. The best candidates for mentorship are those with several startup development experiences [P19, P45]. It is critical that mentors provide early-phase assistance to entrepreneurs and founders and devote enough mentoring time to boost these individuals' confidence and help the ecosystem in the region [P45].

#### *4.5.3. Finance*

Finance is an important element in a startup ecosystem because a startup needs different types of funding at various stages to sustain itself during the product and business development stages and, later, for expansion purposes. A lack of funding can directly influence the creation of startups [P13, P28, P45]. Funding could be from public and private sources and could be categorized as seed funding, stages A–B, and stages C–D, based on the startup's development phase [P58]. Startups can receive funding in multiple ways, including private investments, government grants, crowdfunding, public investments, prizes, and loans [P24, P28]. The following are the sub-elements of finance, from which funds can be generated in the ecosystem:

*Established companies.* Established companies can be among the funding sources. For example, in Japan, established companies, compared with other sources, provide a large amount of funding to startups. The main objective for investment is to create a win-win opportunity for both parties: established companies can use the opportunity to invest in research and development through the medium of startups, whereas startups can gain customer trust if established companies support them [P56]. Another example is Nokia Corporation in Finland, which has invested an immense amount of money over the last two decades, in collaboration with the government, in nurturing local talent and startups [P27, P55].

*Seed investment.* An alternative source of funding can be seed investment, in which past successful entrepreneurs play a major role [P13]. Seed investment is the most common type of investment during the early stages of startups and can be used for preliminary product and business development [P40, P56]. However, if a region lacks a proper financial structure, finding seed investment is a challenge [P6]. Accelerators and incubators, angel investors, and bootstrapping can provide seed investment. Accelerators and incubators can provide direct investment, along with future funding guidance [P28], to startups

during their growth stages. For example, [P4] pointed out that accelerators and incubators invested around US$900,000 in 32 investments, which was similarly observed by [P24]. Angel investors are important sources of seed investment and can constitute the second largest source of funding, after the government [P28]. Angel investors' motive is that if a startup succeeds, their investment could turn into huge profit [P48]. Additionally, early-stage angel funding is beneficial for a startup because it may improve this startup's possibilities to obtain VC funding later [P45]. Another norm in seed investment is bootstrapping, which is common for many startups; here, the funding is generated by founder savings or family members and friends [P20, P25, P28, P31, P53]. Funding from bootstrapping encourages founders to be careful in their expenditures and motivates them to create more profit than other startups that acquire funding from other sources [P20].

*Venture capital funds.* The size of a startup ecosystem can be predicted based on the number of VC funds invested in it [P33]. VC funds are used when innovative startups wish to expand their business and need large sums of funding to further grow [P56]. VC funds can be of international or local forms. Local VC funds are considered during seed to stage B funding, whereas international VC funds are provided during stage C, eventually with the aim of investing in the top global startups [P58].

*Banks* also provide funding to startups in the form of loans, and they assist startups in improving and validating their business plans, with networking opportunities [P14]. A different fund source could be *crowdfunding*, in which startups sell their company shares to the public to generate money [P20]. However, bank loans and crowdfunding are found to be less popular funding sources [P20]. *Government* funds are the major funding source for many startups. Governments create investment funds to establish an optimum environment for startups to grow and promote entrepreneurship in the region [P7, P45].

#### *4.5.4. Demography*

Based on the previous definitions, a startup ecosystem focuses on a particular region. In our analyses, we also foud that demography is an important aspect of a startup ecosystem. The various sub-elements linked to demography and their effects during the development of a startup are as follows:

*Culture and language.* Demography includes culture and language, and a region rich in diverse cultures and languages enables creativity among the local population; in turn, this creativity leads to the creation of innovative ideas, which are vital for early-stage startups [P41, P59]. A startup-culture mindset should be developed among the local population in terms of thinking of large-scale businesses instead of small ones [P50]. Some cultural barriers could be the "lack of certain characteristics such as appetite for risk, entrepreneurial spirit, global ambition, business confidence, and investor understanding of the impacts of technology, as well as resistance to change" [P28]. Governments need to step up their efforts by implementing programs that could overcome these barriers [P58].

*Gross domestic product.* The national gross domestic product (GDP) has an effect on a startup ecosystem. For example, countries with medium income and rising GDP levels, such as China, India, Colombia, Mexico, and Brazil, aim to improve their economies by creating unique startups that can produce excellent products [P19]. Additionally, a favorable GDP environment would facilitate access to cash during the funding stage. For example, in countries such as Luxembourg and Singapore, which have stable GDP levels and financial infrastructure, generating the desired cash that could help in the development of startups is easy [P22, P40].

*Geography.* Geography also influences startups. An example of the geographical impact on startups is Hong Kong's location near the hardware industry, which, in turn, helps Hong Kong develop its technology startups by manufacturing products that incorporate both hardware and software [P58]. A similar case applies to Turkey, which is geographically located in the middle of Europe and Asia. This ideal location creates a strategic advantage for Turkey's startups to avail of new opportunities in Europe and Asia and to explore their markets [P39]. Moreover, if a region is geographically small with a low population density, investing heavily in supporting structures, such as co-working spaces, could be a waste of resources. Therefore, a viable option for allocating resources would be to provide initial education to the local community [P50]. According to one study [P47], the key metrics that determine the geography-related ability to build new businesses are the "number of new business licenses, survival rates, alignment with the economic strategy (e.g., industry sector), retention and returns to the tax base, workforce participation and wage levels, and successful exits from equity investments."

*History.* Some successful startups in a region have a positive impact on the current situation of the startup ecosystem. For example, in Brazil, during the 1998–2008 period, early successful startups (i.e., those that are able to receive funds and were later acquired by established companies) resulted in model startups and prepared the future track for upcoming startups in the Brazilian ecosystem [P12]. The opposite case occurred in New York City, where the first technology startups were already formed during the 1990s; however, due to the dot-com crash in the later part of that decade, the growth of startups came to a standstill, and the city's startup ecosystem remained undeveloped during that stage [P48].

*Immigrants.* Immigrants are often inclined to become technology entrepreneurs than any other group [P56]. This is due to the cultural and language barriers they usually face in any region. This makes immigrants acquire an entrepreneurship mindset in order to establish themselves in a region. The progressive effect of immigrants is evident in areas that have a global environment (e.g., Berlin), leading to the creation of local assets in terms of creativity, talent, or different language skills. These assets can help in developing startups and their surrounding ecosystem [P31, P54].

#### 4.5.5. Market

Startups' growth depends on the number of active users of their products and the number of paying customers. Potential users and customers can be determined by analyzing the product's target market. For startups, the two key market-related subfactors are the "a) local market reach (the size of the local economy and the cultural markets to which a startup has access) and b) the global market reach (a startup's ability to "go global" by growing beyond its national borders)" [P58]. Market size also affects the type of market targeted by the startups in the given ecosystem. For example, because of Armenia's small market size, many startups in the country need to target foreign markets [P61].

*Local market.* Local markets of a smaller size prompt founders to think of going global to expand their startups [P31]. Furthermore, it becomes more difficult for startups to launch their products if the local market is reluctant to accept new and innovative merchandise [P58].

*Global market.* The global market comes into play when the local market size is small. This phenomenon has been observed in Tel Aviv (Israel) and Hong Kong; because of their small market sizes, the startups in these regions face several hurdles to sustain themselves and, therefore, aim to target their products for the global markets [P15, P31, P58]. Reaching out to the global market requires good collaboration with foreign countries. For example, South Korea is collaborating with Japan and China so that large investors and companies from the two latter countries can invest in South Korea's startups, and its startups can gain access to foreign markets [P54].

*Customer.* Customers also influence the market and startups. It is important for startups to understand customers' needs and hear what they have to say in order to stay competitive in the market [P38]. According to [P20], one out of two startups aims to reach individual customers with its products and services. Furthermore, customers from large cities are better for startups than those from small cities, especially in terms of understanding customers' needs and then drawing them to become potential customers in the future. This point may also be a reason why large cities (e.g., London, New York, and San Francisco) aim to create startups [P58]. The other factor that affects the market is *economics*.

#### 4.5.6. Education

Many primary articles consider education as an important element for the creation of a stronger startup ecosystem. For example, one study [P28] mentions that regions that lack educated and experienced entrepreneurs face serious challenges in driving their startup ecosystems. One reason for this lack is the shortage of software development courses in the school curriculum. Good-quality education for startups' founders and entrepreneurs will develop the skills they need for startup success [P35]. In Finland, the dynamic collaboration among educational institutions, research centers, and startups has resulted in the creation and sharing of knowledge required for the development of the startup ecosystem [P55].

*Educational institutions.* The role of educational institutions, such as universities and colleges, is crucial to enhance an innovation-driven economy, nurture local talent, and promote entrepreneurship [P24]. An article [P62] pointed out that a large number of startups have failed because of the lack of entrepreneurship knowledge. Educational institutions, including those offering tertiary education, must develop engineering and entrepreneurship courses and share the courses through their teaching and research programs in order to support and promote an entrepreneurship mindset among students; in turn, these students can consider entrepreneurship as a future career option [P9, P12, P13, P26].

*Experience.* Experience also plays a role in educating entrepreneurs. An individual who has academic and professional knowledge could help in educating entrepreneurs. The knowledge gained during one's study in an academic institution can provide relevant information on product development and entrepreneurship. Similarly, individuals working in companies also gain practical experience regarding product development in a team and customer development in the market. An individual having these kinds of experiences can use such resources to educate himself/herself during startup creation and management. Additionally, an excellent entrepreneur is one who has solid practical experience in previous startups' development. People with experience on a global scale are particularly in high demand, especially as mentors who can educate entrepreneurs and founders in accelerator and incubator programs, where they can share their first-hand global experiences on how to expand startups on a global scale [P41, P45].

*Media.* The media also performs a function in education by providing the information on startups. The young generation is inclined to use social media to connect with family and friends, as well as to obtain information in their fields of interest. The sharing of information through the media is the fastest way to improve individuals' knowledge and perspective on a given topic. For example, updated startup-related news and information could be shared through online forums by using Twitter and Facebook [P19].

*Family.* Family members not only help entrepreneurs by providing them with funding during the seed investment stage, but they also assist in educating and providing moral support that drives entrepreneurs to obtain a degree from an educational institution and create their own startups [P41]. Furthermore, if entrepreneurship is deeply rooted in a family, the members are motivated to engage in entrepreneurship and create their own startups because accumulated learning on entrepreneurship acquired through the family could be transferred to other family members. The other sub-elements that contribute to education are *accelerators and incubators* (described in Section 4.5.2).

#### 4.5.7. Human Capital

A different and important element that emerges from our analyses is human capital, especially in terms of *talent*, which is essential for a startup ecosystem. In long-term economic

growth, human capital with the required skills can be a key driver in the startup ecosystem [P56]. It is the talent of founders and early employees through which startups are created and scaled [P10]. Cities that are interested in developing their ecosystems must provide high-technology companies with the necessary talent and human capital [P43]. The following factors shape human capital:

*Educational institutions.* To nurture the skills of human capital, educational institutions should create the necessary teaching and training programs to draw students' interest in entrepreneurship and startups at a young age [P13, P62]. Educational institutions' curricula must emphasize generating university graduates' interest in entrepreneurship and risk taking. Moreover, job openings in startups must be clearly communicated to young talents [P26, P43]. Section 4.5.6 provides more information on education.

*Government.* The government plays a significant role in human capital development. For example, [P58] pointed out that to bridge its talent gap, the Hong Kong government invests in programs that can help find the required talent. Governments should also emphasize collaboration with other countries through startup events and policies that will enable a startup ecosystem to outsource the desired human capital [P32].

*Policy.* It is important to have a policy that promotes the creation of a startup ecosystem with respect to obtaining investments, attracting a talented workforce, and building cultural diversity [P15]. Governments need to create policies that foster entrepreneurship and startups [P45]. In one article [P58], it was stated that the government of Hong Kong has implemented appropriate immigration policies to recruit more experts in the country's startup ecosystem. To fill the technical talent gap, other governments have proposed policies that are beneficial for startups and high-technology companies. Some of these policies include "expanding entrepreneurship education and mentorship programs; strengthening the commercialization of federally funded Research and Development, which can generate innovative startups and entirely new industries; providing tax relief and incentives for startups; and removing unnecessary regulatory barriers to high-growth startups" [P45].

*Young talents.* Comprising current students or recent graduates, the young talent group can be considered an important part of the human capital for startups. Recent graduates with knowledge of business and engineering can immensely benefit early-stage startups with respect to product development and marketing. However, some studies mention that young graduates are more interested in having a secure job and stable income, leading them to prefer corporate jobs over startup ones [e.g., P58]. Another reason for their preference is that large companies place better advertisements for their job openings through recruitment programs. This situation poses a challenge for startup companies because they lack funding; it is not easy for them to advertise their jobs among young talents [P43]. Additionally, sub-elements, such as *accelerators, incubators* (Section 4.5.2), as well as *experience* (Section 4.5.6), are other factors that affect human capital.

#### *4.5.8. Technology*

From the primary studies, we find that most startups are interested in developing products that incorporate the use of software and technology, which could enable them to target the information technology sector. Thus, technology has an effect on startups and their ecosystem. The following factors help shape technology:

*Geography.* Technology and geography are interrelated in a startup ecosystem. For example, a study [P39] mentioned that the e-commerce sector is important in the Istanbul region because many people prefer making online payments. Therefore, developing product ideas based on the technology that is frequently used in a region can be a strategic advantage for startup founders. Companies, such as Skype and Nokia, have given recognition to Estonia and Finland, for example, as technological countries. For this reason, many startups focus on technology-based products [P29]. A similar case is noted in another study [P58], in which Hong Kong is cited to be in close proximity, geographically, to hardware manufacturing industries, leading local startups to develop products that incorporate both hardware and software in the Internet of Things and wearable devices, among others [P58].

*Established companies.* Large companies influence the regulation of the growth of early-stage firms [P25]. For example, the technology giant IBM has provided all kinds of support tools and solutions to Armenian startups to make their business processes easy and clear [P61]. Nokia has heavily invested in Finnish regions through research and development funds to nurture startups and local talents in technology [P27]. Large technology companies are interested in working with startups and would invest in the latter if there are mutual benefits, along with reduced firm taxes [P36, P40]. Companies, such as Telstra in Australia, drive the application programming interface (API) technology strategy in the country because of API's popularity in the local technology ecosystem. This situation also provides an opportunity for startups that are developing an API application to integrate their work with those of larger companies, such as Telstra [P8, P34].

*Founders.* Another aspect that affects technology is related to the background of a startup's co-founders and the kind of technical expertise possessed by the founder. For example, during their survey on startups, the authors in [P20] found that the majority of founders has experience in running startups and often opt to develop a product in the area of mobile services, e-commerce, and corporate software. One article [P17] reported that highly successful startups mostly come from the information technology sector. However, the study also pointed out that the founder's background has no direct connection with the technology implemented or used by the startup. For example, the startup can obtain hardware and software from its suppliers, and the founder can act as the manager. Nonetheless, the

article also mentioned that having a founder with technical expertise would be a benefit during the early stage of the startup's product development.

*Industry.* The kind of industry available in a region also has an effect on the local startup ecosystem. For example, in Berlin, the information and communication technology sector (Internet services and e-commerce) is on the rise because of the success of startups (e.g., Zalando, Sound Cloud). A similar situation is noted in India, where the e-commerce sector is becoming more important because of the recent startup success of Flipkart and ZipDial. In Hong Kong, the largest startup is in the ICT sector, which all together has 273 startups aiming to develop their products and services mainly in mobile gaming and social media. In Japan, startups target big data and mobile gaming. [P54]

*Innovation.* Innovation has an impact on technology, which subsequently affects a startup. It is also important for a company to develop innovative technology products in the market [P14], and one way to do so is by investigating customer behavior [P20]. The role of innovation was key in the development of the New York startup ecosystem in the 1990s. For example, after the dot-com bubble crash, the city shifted its focus to innovative Internet services. The reduced price of technology also resulted in the escalation of Internet service development. As a technology startup would require technical expertise, along with a business idea, the creation of such startups resulted [P33].

*Product.* Another important sub-element related to technology is the product that a startup develops. In one study [P20], one of two startups was found to focus on the individual customer as the target for its product. It also found that most startups consider themselves as software producers aiming to create a product that could align with the technology industries in areas such as mobile applications, e-commerce, and web services. The product can be developed using existing technologies, such as open-source software, as young technical entrepreneurs know that such software is freely available to all [P11]. During product development, standardized practices (e.g., agile) are used in innovative startups that are progressing toward advancement [P41]. Other factors that affect technology are *business*, *education* (Section 4.5.6), and *foreign collaboration*.

### *4.6. RQ 3-Role of Elements on Startups' Product development*

This study's last objective was to understand the roles of a startup ecosystem's elements in product development. To achieve this objective, we used the stages mentioned by Wang et al. in [15], as shown in Figure 7. The underlying reasons were to obtain a generic view of product development and to use it as a lens to evaluate the roles of a startup ecosystem's elements. According to Wang et al. [15], the product development stages are "concept, in development, working prototype, functional product with limited users, functional product with high growth, and mature product."

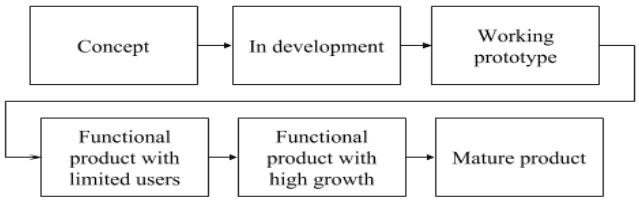


Figure 7: Product development stages

*Concept stage.* In the concept stage, *entrepreneurs* and founders who have innovative ideas try to convert these into business plans in order to establish their own startups [P19, P45]. *Demography* can play a major role in implementing this stage [P39, P58]. For example, regions, such as Silicon Valley, have evolved themselves to support their startups so that these companies can convert their product ideas into actual products and become global unicorns [P45]. *Incubators* and *accelerators* come into play by providing entrepreneurs and founders with proper *mentorship* in *co-workspaces* during the concept stage; as a result, these individuals can develop and transform their ideas into real startups [P14, P22, P29]. *Seed investment* occurs during the seed stage, in which startups can obtain funding from incubators and accelerators, angel investors, and bootstrapping [P13, P28, P40]. The funding can be used to develop the initial prototype of the proposed product or service concept [P41]. With seed-stage funding, *market* research is conducted to identify potential customers and seek market acceptance of the product [P58, P61]. To analyze the market and validate the product concept among *customers*, the conduct of interviews with potential customers can happen.

*In development/working prototype.* In this stage, the actual *product* development occurs, and the idea initiated during the concept stage is validated. Founders provide support in the development of the product [P20]. Furthermore, if the product is integrated with *technology*, the use of open-source technologies can be considered because of its free availability, thus reducing development costs [P11, P19]. Seed investment can be utilized during this stage.

*Functional/mature product.* During this stage, the use of standardized methodologies, such as agile methods for product and customer development, can happen [P11, P18, P19]. As the product grows with large users, *human capital* (comprising talented people) is hired to develop the product features. Considering the *market* for the mature product is important for its scalability [P38]. As the product development evolves, additional personnel should be hired, and, thus, more funding is required, which can be acquired through *venture capitalists* [P56].

## 5. Discussion

In this section, we present the summary of the findings (Section 5.1), reflect on the contributions of our study (Section 5.2) along with implications of our results (Section 5.3). Finally,

we compared Startup and Entrepreneurial Ecosystems (Section 5.4), and, discuss the validity aspects of our study.

### 5.1. Summary of Findings

A startup is an important feature of economic growth, especially in job creation. The elements of a startup ecosystem play a decisive role in nurturing the startup. However, systematic literature reviews that reflect on these aspects are limited. In our study, we aimed to explore the startup ecosystem in existing literature in order to organize and analyze studies on it and to answer our RQs, as proposed in Section 3 and discussed as follows:

#### 5.1.1. Overview of articles and their research types, contributions, and pertinence

Our research aims to obtain an overview of primary articles on the elements of a startup ecosystem and to determine the current research situation in the startup ecosystem literature in terms of research types, contributions, and pertinence. We find that the amount of gray literature clearly exceeds that of technical articles on the startup ecosystem (see Figure 3b). Regarding years of publication (see Figure 3c), there is a continuous increase in articles published over the last five years (2012–2016). Additionally, we show the number of regional and national cases worldwide, with their reference numbers (see Figure 3a). As far as current research is concerned, in terms of research type, over 50% of the articles belong to the combined experience and opinion categories. In terms of contribution type, 43 articles are reports, whereas 18 are empirical and qualitative studies. The large number of experience and opinion articles with a report contribution is due to the huge amount of white papers and gray literature. This finding indicates the need for research on startup ecosystems that use proper scientific methods. Furthermore, over 50% of the articles have full pertinence, signifying that most of the papers we found actually discuss the startup ecosystem.

#### 5.1.2. RQ1. Definitions of a startup ecosystem

Our first RQ aims to identify the definitions of a startup ecosystem that are presented in the literature. Out of 63 relevant articles, four offer some kind of definition in relation to it. Based on the given definitions (see Section 4.4), a startup ecosystem operates in an environment located in a specific region. It includes actors that can act as stakeholders, such as entrepreneurs, investors, and other people with some self-interest in the ecosystem. It also collaborates with supporting organizations, such as funding agencies, governments, academic institutions, and established companies, to create an infrastructure in which a common network that could support and build startups on a smaller scale, as well as increase a country's domestic product development and job creation on a larger scale, is established.

#### 5.1.3. RQ2. Elements of a startup ecosystem

Our next aim is to understand the elements of a startup ecosystem, which are identified from the 63 articles, to answer our second RQ. Eight important elements that affect startups have emerged (with a focus on software-intensive products), and these are as follows: entrepreneurs, finance, market, technology, human capital, education, demography, and supporting factors (Figure 8). Regarding *supporting factors*, we find

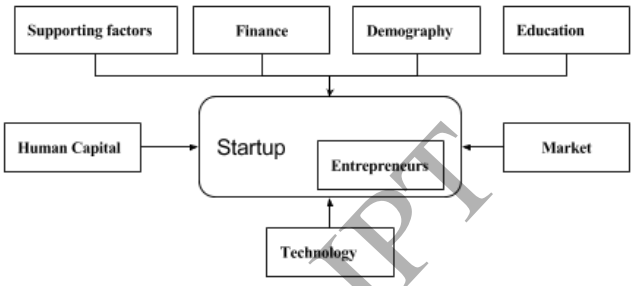


Figure 8: Key elements in a startup ecosystem

that incubators and accelerators are important for early-stage founders and entrepreneurs in terms of providing proper mentorship so that the two latter groups can improve their business ideas and convert these into viable business plans. The programs they manage operate in co-working spaces where stakeholders can collaborate and network to help develop the startups. This process could occur through the creation of events held at specific locations. Governments create programs and provide funding for entrepreneurs. The next important element is *finance*, which is required throughout the product and customer development stages. Funding can be possible through angel investors, established companies, venture capitalists, banks, governments, and crowdfunding. A region's *demographic* factors also affect its startup ecosystem. Demography encompasses the region's culture and language, geographic location, history, and number of immigrants.

Another element is the *market*, which could be local or global in scope, and is influenced by customers and the kind of business in which a startup is engaged. The next element in the ecosystem is *education*, which is important for teaching young talents in educational institutions, where they receive the training they require for creating startups. Educational institutions, accelerators and incubators, experience, and family and media all play roles in creating the educational environment. *Human capital* is one more element derived from the literature, and it is influenced by accelerators and incubators, education, experience, the government, policies, and young talents. The last two elements are *technology* and *entrepreneurs*. A comparison of business ecosystem elements in existing literature (e.g., [P41, P45, P50] see Table 3) shows that some are common in the three cited articles, with technology as the only missing element in two articles [P45, P50]). The reason could be our inclusion criteria, which include only those articles that present an aspect of technology.

#### 5.1.4. RQ3. Role of elements in startups' product development

Our third RQ explores which elements affect startups' product development. To answer this question, we use product development stages, as described in [15]. With respect to the ele-

ments' role in product development, we find that in the concept stage, founders and entrepreneurs convert their innovative ideas into business plans to set up their startups. During this stage, incubators and accelerators can provide them with proper mentorship in common workspaces. During the in-development/prototype stage, development can occur with the use of open-source technology and development methods. In the functional/mature product stage, human capital (talented people) is hired to develop product features, along with the use of standardized practices, such as agile methods. In addition, venture capitalists can come into play by providing additional funding to support the growing product.

### 5.2. Key Contributions to the Literature

As discussed in Section 2.3, various literature reviews exist, and these focused on aspects such as software development practices in startup companies [7] [8], entrepreneurial ecosystems [3, 23], and technology startup ecosystems [24]. However, all the mentioned reviews lack a description of startup ecosystems. For example, the main focuses were on software development in startup companies [7] [8], the important components in an entrepreneurial ecosystem [3, 23], and the key elements framing the technology startup ecosystem (but the paper was not in English) [24]. This highlights the lack of literature review focusing on startup ecosystems.

Basing on the analyses of the articles, our study makes four contributions to broaden knowledge on this topic. First, the current state of research on this topic is highlighted (Figure 4). Second, four existing definitions of a startup ecosystem are presented to show the similarities and differences among them and to evaluate such definitions using suitable criteria for the creation of a unique description of a startup ecosystem. Third, a startup ecosystem's eight major elements and their sub-elements (Table 4), as well as their roles, are discussed in detail in Section 4.5. Finally, we examine the role of such elements in product development in Section 4.6. We also provide several recommendations for future research on this topic in the conclusion section.

### 5.3. Implications for Practice and Research

Our research highlighted (Figure 4) that few scientific studies exist on the startup ecosystem phenomenon, and, therefore, we needed to incorporate gray literature in our systematic research to create the state of the art on the topic. This implies that researchers need to do further research on the topic through rigorous and empirical means in order to explore the phenomenon in more detail. Furthermore, our study highlights that the startup ecosystem is a regional phenomenon, and, therefore, research needs to be performed in a regional context in order to explore and describe the different elements in a startup ecosystem. Our study also contributes to the body of knowledge on this topic by considering academic researchers' and practitioners' viewpoint. The research findings may encourage future research that investigates and differentiates between startup and entrepreneurial ecosystems.

With respect to implications for practice, during the stage of inclusion and exclusion of articles for our multi-vocal literature review, we decided to include only those papers that actually discuss real cases of startup ecosystems. We found many such cases worldwide, increasing the credibility of the data we used to answer our RQs. Moreover, Table 2 shows the articles that pertain either fully or marginally to startup ecosystems. Full-pertinence articles are ideal candidates for examining startup ecosystems in practice. Another aspect that can be related to practice can be observed from the real cases found, as shown in Figure 3a. The figure also shows the references describing the cases. Therefore, contextual information about the startup ecosystem in a particular region can be found in the relevant reference(s). For example, people from Southern Africa can read P11 and P26 to know these articles' discussions regarding South Africa and Zimbabwe. Additionally, the elements discussed in Section 4.5 with respect to the startup ecosystem can provide the following benefits:

- Help practitioners understand the important elements of a startup ecosystem and use them as a framework to analyze their region's situation in this context. Especially for inexperienced entrepreneurs, our results highlight opportunities, such as offering finance, people, and supporting factors (Table 4). On the other hand, our findings also emphasize the complexity of the ecosystem as an operational environment.
- Enable practitioners to examine more closely which sub-elements have effects on a particular main element. For example, practitioners can investigate what types of funding are available for startups.
- Lend support in clarifying the conceptual model for potential stakeholders that are interested in creating startups or improving the existing ones in a particular region with respect to the startup ecosystem
- Help stakeholders evaluate the current situation in terms of one or several elements of their regional startup ecosystem

### 5.4. Comparison of Startup and Entrepreneurial Ecosystems

In Section 2.2, we have briefly compared startup and entrepreneurial ecosystems to identify whether both concepts are similar or have some differences. In this section, we compare the elements of the entrepreneurial ecosystem described by Neck et al. [45] with those we have found (Table 4). In their case study of Boulder County, Colorado, USA, Neck et al. found several elements of the entrepreneurial ecosystem, which are as follows: "incubator spinoff relationship (incubator, implicit spinoffs, explicit spinoffs, and second- and future-generation spinoffs), county, informal networks (friends, families, colleagues, and informal relations with similar high-technology companies), and formal networks (universities, governments, professional and support services, capital sources (e.g., venture capitalists, business angels, and banks), talent pools, large corporations, physical infrastructure, and culture." A comparison of the above-mentioned elements with those described in Table 4 shows that many elements are similar. For example, the sub-elements of informal networks and formal

networks are shown in Table 4. Similarly, county, physical infrastructure, and culture are included in demography (Section 4.5.4). Several differences emerge, too. For example, the incubator spinoff relationship does not appear in our study. The meaning of the word *incubator* in Neck et al.'s study differs from that in our study. They describe it as an "organization where the entrepreneur was employed before starting his or her new venture," whereas in our study, we find that an incubator helps in the initial stage of a startup through mentorship (see Section 4.5.2).

### 5.5. Validity Discussion

Our study's validity is discussed based on the criteria mentioned in previous studies [46, 47]. Using such criteria, including external, conclusion, internal, and construct validity, we have tried to address the potential validity threats to our study and performed mitigation strategies to overcome such threats, as recommended in the aforementioned study [47].

*External validity.* It refers to how much a study's results can be generalized [46, 47]. To increase the scope of generalization, we have ensured that the startup-related keywords used in our study were already used in previous literature reviews on the topic. To further improve generalizability, we have ensured that those included as primary articles discuss real cases of startup ecosystems worldwide. This way, the data obtained from the primary articles have validity in answering our RQs and are relevant to practice. One threat to external validity can be the limited time duration of the literature. To address this issue, we do not apply any time limit during our search process in the databases, and, therefore, the literature that was retrieved was from 2000 until 2016. Another threat would be regarding the inadequate research evidence in the primary articles. This threat is valid in our study because multiple articles are in the form of gray literature, in which some articles have brief information on the startup ecosystem phenomenon.

*Conclusion validity.* Conclusion validity refers to whether an appropriate process was used to arrive at reliable conclusions and whether the same outcomes would be achieved if the process was repeated [46, 47]. To ensure this validity, three researchers worked on the literature search evaluation, DE, and synthesis procedure. The first and the second researchers simultaneously performed searches on the mentioned electronic databases and Google's search engine by using the defined protocol. Once the final primary articles were retrieved, the first and the third researchers jointly conducted the DE and the QA. The objective was to ensure that there would be no single researcher bias in the process. One threat could be the inappropriate classification of the primary articles. To address this threat, we used existing guidelines, such as those in two previous studies [38] and [39], in order to assess the articles in terms of research classification and contribution. Another threat could be related to primary study replication, and to address this threat, we used tools, such as StArt and Microsoft Excel, in order to automate the literature review process and to find and remove the duplicate articles.

*Internal validity.* This involves determining if there is a causal relationship between two factors and a risk that a third factor has an effect on the examined factor [46, 47]. One threat related to internal validity could be bias during DE. To address this threat, first, two researchers jointly executed the DE phase in order to avoid any bias. Another threat could be regarding the subjective QA of the primary articles. To overcome this threat, we used existing guidelines, such as those in previous studies [40] and [41], in order to assess the quality of the scientific and gray literature articles separately. Furthermore, to avoid any bias during the QA, the process was executed and checked by the first two researchers together.

*Construct validity.* Construct validity involves exploring the appropriate operational measures for the theory under investigation, along with determining whether such operational measures denote the perspective of the researcher and the investigation supports the RQs [46, 47]. The RQs are framed in such a way that they address our research objectives, considering the limited studies on the topic. Through our RQs, we aim to explore the state of current research on the startup ecosystem, its definition in the literature, and the important elements that constitute the ecosystem. We propose the last RQ to identify which elements of the ecosystem affect a startup's product development. One threat related to construct validity could be the unclear description of the systematic literature review setting. To overcome this threat, we created a review protocol in which we followed guidelines from existing literature with respect to the identification of technical literature and gray literature separately; furthermore, the use of tools also helped in providing specifications for the literature review setting. Another threat could be related to the use of inappropriate search words. To address this threat, we ensured that we used keywords that were already used in existing literature reviews on studies and thus would be suitable for finding relevant literature on the startup ecosystem phenomenon.

## 6. Conclusion and Future Work

Startups constitute an important aspect of a nation's economic growth. They contribute to job creation and economic development at both regional and national levels. Several breakthrough innovations and the largest businesses have been generated by startups; thus, their potential is real. To nurture a startup, the stakeholders interested in its development need to collaborate in the form of a network in which they create a relationship as an ecosystem. However, to the best of our knowledge, the context of a startup ecosystem through a literature review has not yet been explored.

This study has been designed using a multi-vocal literature technique to determine the existing status of research on the startup ecosystem, its relevant definitions, its important elements, and these elements' role in a startup's product development stages. The multi-vocal literature technique has helped us accumulate technical articles, white papers, and Internet articles from several electronic databases and Google's search engine. In total, 63 articles have been selected from the initial 18,310

articles that discuss various startup ecosystem cases worldwide. Basing on the analyses of the articles, our study makes five contributions regarding this topic. First, we provide an overview of relevant literature on this topic in terms of article type (Figure 3b), year of publication (Figure 3c), and location of the case discussed in each paper (Figure 3a). Second, we show the current state of research on this topic (Figure 4), in which we find 34 articles belonging to the opinion category, with contributions in the form of reports. Additionally, more than 50% have full pertinence to the startup ecosystem. Third, we present four definitions of a startup ecosystem. They share common terms, such as stakeholders, supporting organizations, infrastructure, network, and region. Fourth, we find eight major elements (Table 4) that constitute the startup ecosystem. Finally, we show the role of these elements in a startup's product development.

*Future Work.* Our study sheds light on various new directions recommended for the startup ecosystem, and future research can explore these further. Figure 4 shows that there are a limited number of technical papers that have full pertinence and that evaluate the topic through empirical means. Therefore, the first research direction would be to assess the eight discussed themes (Figure 8) by examining using either case studies or surveys in regional cases.

Another recommendation for future research would be to compare and contrast startups and entrepreneurial ecosystems by evaluating the literature to determine their commonalities and differences. In our future work, we plan to test the framework in a Finnish regional case (Oulu City) and examine the role of the elements of a startup ecosystem in product development.

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## APPENDIX A: Primary articles

[P1] D.I. Lewin, Teaching techies to become entrepreneurs, Comput. Sci. Eng. 2 (2000) 6-9. doi:10.1109/5992.841790.

[P2] A. Kureth, Polish nonprofit tries building startup ecosystem. http://www.politico.eu/article/polish-startup-ecosystem-it/, 2015 (accessed November 1, 2016).

[P3] J. Warsta, V. Seppanen, Value network positioning of expected winners: Analysis of the top software business start-ups, Res. Pract. Issues Enterp. Inf. Syst. II, Vol 1. 254 (2008) 43-52.

[P4] S. Gardens, Slovenian Startup Ecosystem 2015. Doubling in size since 2007. http://www.silicongardens.si/ecosystem2015/, 2015 (accessed November 1, 2016).

[P5] G. Elia, A. Margherita, G. Secundo, G. Passiante, Building an "i-Learning" environment for entrepreneurial engineering, 2011 IEEE Glob. Eng. Educ. Conf. EDUCON 2011. (2011) 1201-1206. doi:10.1109/EDUCON.2011.5773300.

[P6] Startup Daily, The mission to grow the "Chilecon Valley" startup ecosystem. http://www.startupdaily.net/2015/02/mission-grow-chilecon-valley-startup-ecosystem/, 2015 (accessed November 1, 2016).

[P7] T. Bradley, Seeding a Silicon Valley: How Poland is creating a startup ecosystem from scratch. http://qz.com/3396/seeding-a-silicon-valley-how-poland-is-creating-a-startup-ecosystem-fr 2012 (accessed November 1, 2016).

[P8] S. Daily, The rise of API-ification within the Australian and New Zealand startup ecosystem. http://www.startupdaily.net/2015/07/rise-api-ification-within-australian-new-zealand-startup-ecosystem/, 2015 (accessed November 1, 2016).

[P9] Larrygr, Startup Ecosystem Reference Model. http://www.competegy.com/tag/local-software-economy/, 2012 (accessed November 1, 2016).

[P10] Startupsmart, Melbourne' s startup ecosystem: where to from here?. http://www.startupsmart.com.au/advice/business-planning/melbournes-startup-ecosystem-where-to-from-here/, 2015 (accessed November 1, 2016).

[P11] L.S.. Kabweza, The role of government in fostering an active tech startup ecosystem. http://www.techzim.co.zw/2012/04/the-role-of-government-in-fostering-an-active-tech-startup-ecosystem/, 2016 (accessed November 1, 2016).

[P12] W.S. Wiki, Brazil Startup Ecosystem. http://www.worldstartupwiki.org/page/BrazilStartupEcosystem, 2016 (accessed November 1, 2016).

[P13] M. Libes, 6 Components of a Thriving Startup Ecosystem. http://www.triplepundit.com/2012/08/consciously-creating-startup-ecosystem/, 2012 (accessed November 1, 2016).

[P14] Pronovix, The Belgian Startup Ecosystem. https://github.com/Pronovix/Belgian-startup-ecosystem/wiki/The-Belgian-Startup-Ecosystem, 2015 (accessed November 1, 2016).

[P15] B.L. Herrmann, M. Marmer, E. Dogrultan, D. Holtschke, Startup Ecosystem Report: Part One. http://www.investtoronto.ca/InvestAssets/PDF/Reports/Startup-Ecosystem-Report-2012.pdf, 2012 (accessed November 1, 2016).

[P16] Startup Daily, The future of Australia's startup ecosystem: Perspectives from Queensland founders and politicians. http://www.startupdaily.net/2015/05/future-australias-startup-ecosystem-queensland-political-perspective/, 2015 (accessed November 1, 2016).

[P17] S.W. Foo, Lessons from successful technology based startups, 2012 Int. Symp. Manag. Technol. ISMOT 2012. (2012) 122-127. doi:10.1109/ISMOT.2012.6679441.

[P18] Vladimir Krajcik and Ivo Formanek. Regional startup ecosystem. European Business & Management, 1(2):14–18, 2015.

[P19] R. Cervantes, B. Nardi, Building a Mexican startup culture over the weekends, Proc. 4th Int. Conf. Intercult. Collab. (2012) 11-20. doi:10.1145/2160881.2160884.

[P20] A. Skala, E. Kruczkowska, M.A. Olczak, Polish Startups. http://startuppoland.org/wp-content/uploads/2015/10/Startup-Poland-raport-ENG-01.pdf. , 2015 (accessed November 1, 2016).

[P21] S. Kulkarni, 10 investors in India startup ecosystem. http://www.zdnet.com/article/10-investors-in-india-startup-ecosystem/, 2013 (accessed November 1, 2016).

[P22] Infocomm Investments, Singapore Startup Ecosystem. http://www.infocomminvestments.com/docs/SGStartupEcosystem2015(IIPL).pdf, 2015 (accessed November 1, 2016).

[P23] C.S. Sakawee, 3 big problems with the Thai startup ecosystem. https://www.techinasia.com/3-big-problems-thai-startup-ecosystem , 2013 (accessed November 1, 2016).

[P24] Boundlss, Startup Ecosystem Preliminary Report. http://www.startupwa.org/docs/Western_Australia_Startup_Report_Dec_2015.pdf, 2015 (accessed November 1, 2016).

[P25] World Economic Forum, Entrepreneurial Ecosystems Around the Globe and Company Growth Dynamics. http://www3.weforum.org/docs/WEF_EntrepreneurialEcosystems_Report_2013.pdf, 2013 (accessed November 1, 2016).

[P26] PwC South Africa, Working together, moving forward: Emerging companies and the ecosystem. https://www.pwc.co.za/en/assets/pdf/emerging-companies-and-the-ecosystem.pdf, 2015 (accessed November 1, 2016).

[P27] T. Laine, T. Polo, How Oulu became a thriving startup ecosystem in 3 years. http://arcticstartup.com/article/how-oulu-became-a-thriving-startup-ecosystem-in-3-years/, 2014 (accessed November 1, 2016).

[P28] N. Markham, M. Kruger, J.C. From, Startup Ecosystem Report: Regional Queensland. https://www.qld.gov.au/dsiti/assets/documents/regional-qld-startup-ecosystem-report.pdf, 2015 (accessed November 1, 2016).

[P29] M. Odineca, The ArcticStartup guide to: Estonia. http://arcticstartup.com/article/the-arcticstartup-guide-to-estonia/, 2014 (accessed November 1, 2016).
[P30] S. Gupta, R. Pienta, A. Tamersoy, D.H. Chau, R.C. Basole, Identifying Successful Investors in the Startup Ecosystem, Proc. 24th Int. Conf. World Wide Web - WWW '15 Companion. (2015) 39-40. doi:10.1145/2740908.2742743.
[P31] R. Wauters, A look at Europe's top startup countries: the good, the bad and the ugly. http://tech.eu/features/3256/europe-top-startup-countries-good-bad-ugly/, 2014 (accessed November 1, 2016).
[P32] P. Adamovsky, Startup ecosystem to expect smart progress. http://spectator.sme.sk/c/20067486/startup-ecosystem-to-expect-smart-progress.html, 2016 (accessed November 1, 2016).
[P33] N. Beim, The rise And future of the New York startup ecosystem, TechCrunch. http://techcrunch.com/2014/02/28/the-rise-and-future-of-the-new-york-startup-ecosystem/files/620/the-rise-and-future-of-the-new-york-startup-ecosystem.html, 2014 (accessed November 1, 2016).
[P34] I. Spiegel, A spotlight on the startup ecosystem in Lisbon, Portugal. http://tech.eu/features/2166/spotlight-on-lisbon-startups/, 2014 (accessed November 1, 2016).
[P35] N. Farrell, Brisbane's Startup Scene. http://www.pollenizer.com/2014/04/04/brisbanes-startup-scene/, 2014 (accessed November 1, 2016).
[P36] M. Khoso, Boston's Startup Ecosystem. http://www.northeastern.edu/econsociety/special-report-bostons-startup-ecosystem/, 2016(accessed November 1, 2016).
[P37] D. Footer, San Diego, Baja can have sustainable startup ecosystem. http://www.sandiegouniontribune.com/news/2014/jul/09/san-diego-baja-startup-ecosystem/, 2014 (accessed November 1, 2016).
[P38] A. Sharma, What Tech-Enabled Startups Should Do to Grow in a Turbulent Economy. http://www.pcquest.com/what-tech-enabled-startups-should-do-to-grow-in-a-turbulent-economy/, 2016 (accessed November 1, 2016).
[P39] N. Horn, The Istanbul startup ecosystem is on the rise- what you need to know Istanbul Ecosystem. http://www.seedstarsworld.com/blog/2014/07/the-istanbul-startup-ecosystem/ , 2014 (accessed November 1, 2016).
[P40] R. Herring, Luxembourg, Building on Old Habits, Births a Tech Ecosystem. http://www.redherring.com/finance/luxembourg-building-old-habits-births-tech-ecosystem/, 2016 (accessed November 1, 2016).
[P41] F. Kon, D. Cukier, C. Melo, O. Hazzan, H. Yuklea, A Conceptual Framework for Software Startup Ecosystems: the case of Israel. Technical Report RT-MAC-2015-01, June 2015.
[P42] Inventure, Lviv Startup Ecosystem. https://inventure.com.ua/en/news/ukraine/lviv-startup-ecosystem, 2015 (accessed November 1, 2016).
[P43] Endeavor Miami, A Platform to Accelerate the Development of Local Entrepreneurship Ecosystems Case: Miami , Florida. http://endeavormiami.org/Endeavor-City_Hubs_for_Entrepreneurship-Miami.pdf, 2014 (accessed November 1, 2016).
[P44] Infocomm Media Development Authority, It takes an ecosystem to raise a start-up. https://www.imda.gov.sg/infocomm-and-media-news/buzz-central/2015/2/it-takes-an-ecosystem-to-raise-a-startup, 2016 (accessed November 1, 2016).
[P45] A. Turner, Crossroad: An action plan to develop a vibrant tech startup ecosystem in Australia. http://startupaus.org/wp-content/uploads/2014/04/StartupAUS-Crossroads-report-FINAL.pdf, 2014 (accessed November 1, 2016).
[P46] J. Elias, Building Small Town Startup Ecosystems, On Connection at a Time. https://www.startupgrind.com/blog/building-small-town-startup-ecosystems-on-connection-at-a-time/, 2016 (accessed November 1, 2016).
[P47] R. Works, Differentiating Our Startup Ecosystem: Virginia the New Leader in Entrepreneurship - Richmond at the Center.http://www.richmondeda.org/LinkClick.aspx?fileticket=m0jBZ95p_c8%3D&portalid=0, 2014 (accessed November 1, 2016).
[P48] D. Cukier, F. Kon, T.S. Lyons, Software Startup Ecosystems Evolution: The New York City Case Study, 2nd Int. Work. Softw. Startups. (2016).
[P49] M.H. Sadi, E. Yu, Analyzing the evolution of software development: From creative chaos to software ecosystems, Proc. - Int. Conf. Res. Challenges Inf. Sci. (2014). doi:10.1109/RCIS.2014.6861055.
[P50] T. Haines, Developing a Startup and Innovation Ecosystem in Regional Australia, Technol. Innov. Manag. Rev. 6 (2016) 24-32.
[P51] M. Dumas, The Rise of the Estonian Startupsphere, IT Prof. Mag. 16 (2014) 8-11. doi:http://doi.ieeecomputersociety.org/10.1109/MITP.2014.62.
[P52] J. Smit, Startup-Ecosystems in ASEAN member states. http://apwberlin.de/wp-content/uploads/2016/02/ASEAN_Startup_Ecosystems.pdf, 2016 (accessed November 1, 2016).
[P53] H. Cho, Dallas startup ecosystem makes major strides in 2015. http://www.dallasnews.com/business/small-business/20151204-dallas-startup-ecosystem-makes-major-strides-in-2015.ece, 2015 (accessed November 1, 2016).
[P54] A.-P.F. Berlin, Startup Cities. http://apwberlin.de/wp-content/uploads/2016/05/APW-2016_Startup-Cities.pdf, 2016 (accessed November 1, 2016).
[P55] R. Korbet, Geektime Report: The state of Finland's VC and startup ecosystem. http://www.geektime.com/2015/03/30/geektime-report-the-state-of-finlands-vc-and-startup-ecosystem/, 2015 (accessed November 1, 2016).
[P56] Knight Foundation, Catalyzing Connections: The State of Miami's Startup Ecosystem. http://www.knightfoundation.org/media/uploads/publication_pdfs/kf_miami_startup.pdf, 2016 (accessed November 1, 2016).
[P57] B.E. Stewart, Mexico's Start-Up Ecosystem Drives Talent Development and " Global Reach ,". http://www.nearshoreamericas.com/mexicos-startup-ecosystem-drives-talent-development-innovation/ , 2015 (accessed November 1, 2016).
[P58] Compass.co, Hong Kong Startup Ecosystem Report. http://reports.startupgenome.com/reports/HongKongStartupEcosystemReport.pdf, 2016 (accessed November 1, 2016).
[P59] S.A. K, "Latin American startup ecosystem is 10-12 years behind India," (2015). https://e27.co/latin-american-startup-ecosystem-is-10-12-years-behind-india-20150708/ 2015 (accessed November 1, 2016).
[P60] Microsost Accelerator, The Indian Startup Ecosystem Timeline. https://www.microsoftaccelerator.com/blog/entry/HistoryoftheIndianStartupEcosystem-Infographic%7C6177, 2016 (accessed November 1, 2016).
[P61] A. Gasparyan, IBM promoting development of Armenia' s startup ecosystem. http://www.panarmenian.net/eng/details/199769/, 2015 (accessed November 1, 2016).
[P62] A. Zavodska, V. Sramova, A. Rybovic, Developing Entrepreneurial Education at the University Focused on Start-ups, Proc. 11th Int. Knowl. Manag. Organ. Conf. Chang. Face Knowl. Manag. Impacting Soc. (2016) 37:1–37:7. doi:10.1145/2925995.2926008.
[P63] S. Gill, "Amazon Of Argentina" Funding Shines Light On Blossoming Tech Ecosystem. http://www.pivotl.com/2015/11/20/amazon-of-argentina-funding-shines-light-on-blossoming-tech-ecosystem/ 2015 (accessed November 1, 2016).

## APPENDIX B: Primary articles discussing on the startup ecosystem and their pertinence

| ID | Description in relation startup ecosystem | Pertinence |
|---|---|---|
| [P1] | Teaching technical people about entrepreneurship and role of education in initiating startups in the region | Partial |
| [P2] | Discussion on how Poland is trying to build startup ecosystems | Partial |
| [P3] | Position of startups with respect to value generation in emerging markets | Marginal |
| [P4] | Progress of Slovenian startups' ecosystem | Partial |
| [P5] | Development of a learning environment that can facilitate the training of future entrepreneurs | Marginal |
| [P6] | Ecosystems started in Chile and how the country has been transformed into a technological and entrepreneurial hub | Partial |
| [P7] | How Poland is trying to establish its startup ecosystem from ground zero | Full |
| [P8] | Importance of APIs and how they affect the technological startup ecosystem and the large companies around it | Full |
| [P9] | A reference model for the startup ecosystem and its elements | Full |
| [P10] | Discussion on Melbourne's startup ecosystem and how it can be one of the top five ecosystems in the world | Partial |
| [P11] | The government's role in the development of a startup ecosystem in Zimbabwe | Partial |
| [P12] | Description and examples of the elements of the Brazilian startup ecosystem | Full |
| [P13] | Discussion on six elements that are important in developing a startup ecosystem | Full |
| [P14] | Belgian startup ecosystem and examples of its supporting elements | Partial |
| [P15] | Discussion on individual startup ecosystems in such locations as Israel and Los Angeles | Full |

| | | |
|---|---|---|
| [P16] | Discussion on Australia's startup ecosystem and the politician's roles and opinions about it | Partial |
| [P17] | Discussion on some successful startups, such as Google | Partial |
| [P18] | Examination of the regional startup ecosystem model and its true nature to develop a progressive business environment | Full |
| [P19] | Sharing the experience in the development of startups during one weekend to establish a startup culture and ecosystem in Mexico | Full |
| [P20] | Reflections on Polish startups through a survey and discussion of different aspects | Full |
| [P21] | Discussion on top 10 investors in India's startup ecosystem, with descriptions and examples | Partial |
| [P22] | Reflections on Singapore's startup ecosystem and how elements such as accelerators are appearing to help it | Full |
| [P23] | Present challenges in Thailand's startup ecosystem | Partial |
| [P24] | Reflections on Western Australia's startups in accordance with the startup ecosystem's elements | Full |
| [P25] | Discussion on the elements of entrepreneurial ecosystems and cases worldwide | Full |
| [P26] | Reflections on startups in South Africa | Full |
| [P27] | Discussion on startup ecosystems in Oulu, Finland | Full |
| [P28] | Discussion on startups in Queensland, Australia | Full |
| [P29] | Discussion on startups in Estonia and the role of the ecosystem's elements in nurturing startups | Full |
| [P30] | Discussion about finding successful investors in the startup ecosystem | Full |
| [P31] | Discussion on examples of some successful cities in Europe with respect to startup ecosystems | Partial |
| [P32] | Discussion on Slovak startups and how their elements are helping in the progress of the ecosystem | Full |
| [P33] | Discussion on New York's startup ecosystem and some examples of its elements | Full |
| [P34] | Discussion on Lisbon's startup ecosystem, with the role of the elements in supporting the startups | Partial |
| [P35] | Discussion on Brisbane's startup situation | Full |
| [P36] | Discussion on Boston's startup ecosystem and its various elements | Full |
| [P37] | Reflections on San Diego's startup ecosystem | Partial |
| [P38] | Reflections on ecosystems in India and how startups should address the difficult market and economy | Full |
| [P39] | Discussion on Istanbul's startup ecosystem | Partial |
| [P40] | Discussion on Luxembourg's startup situation, with supporting ecosystem elements | Partial |
| [P41] | Discussion on Israel's startup ecosystem, with its elements | Full |
| [P42] | Discussion on startup ecosystem in Lviv, Ukraine | Partial |
| [P43] | Discussion on Miami's startup situation and its ecosystem | Full |
| [P44] | Highlighting the ecosystem's importance with respect to the startup's growth | Partial |
| [P45] | Action plan on how to establish a vibrant technological startup ecosystem in Australia | Full |
| [P46] | Focus on the startup ecosystem in a small town | Full |
| [P47] | Discussion on Virginia's startup ecosystem and comparison with other ecosystems | Full |
| [P48] | Discussion on New York's startup ecosystem as a case study | Full |
| [P49] | Limited discussion on startup ecosystems | Marginal |
| [P50] | Description of the development of startup ecosystems in regional Australia | Full |
| [P51] | Discussion on Estonia's startup ecosystem situation | Full |
| [P52] | Examples of startup ecosystem elements in the ASEAN countries | Partial |
| [P53] | Discussion on Dallas' startup ecosystem | Full |
| [P54] | Discussion on various startups in cities worldwide and their ecosystems | Full |
| [P55] | Finnish startup ecosystem and examples of its supporting elements | Partial |
| [P56] | Discussion on Miami's startup ecosystem | Full |
| [P57] | Discussion on Mexico's startup ecosystem and the role of talent in it | Partial |
| [P58] | Reflections on Hong Kong's startup ecosystem and comparisons with other ecosystem cases worldwide | Full |
| [P59] | Situation of Latin America ecosystem and comparison with India's startup ecosystem | Partial |
| [P60] | Description of India's startup ecosystem and timeline from Microsoft's perspective | Full |
| [P61] | Reflections on large companies' (e.g., IBM) role in Armenia's startup ecosystem | Full |
| [P62] | Emphasis on entrepreneurial education in the universities to support the startup ecosystem in the region | Partial |
| [P63] | Discussion on two South American countries and their technological startup ecosystems | Partial |

## References


[1] Tim J. Kane. The importance of startups in job creation and job destruction. 2010. URL `http://dx.doi.org/10.2139/ssrn.1646934`.

[2] Martin A. Carree and A. R. Thurik. *The impact of entrepreneurship on economic growth*, pages 557–594. Handbook of entrepreneurship research. Springer, 2010.

[3] Boyd Cohen. Sustainable valley entrepreneurial ecosystems. *Business Strategy and the Environment*, 15(1):1–14, 2006.

[4] Martin Kenney and Urs Von Burg. Paths and regions: the creation and growth of silicon valley. *Path dependence and creation*, pages 127–148, 2001.

[5] Anthony R Ives and Stephen R Carpenter. Stability and diversity of ecosystems. *science*, 317(5834):58–62, 2007.

[6] Saku J. Mäkinen and Ozgur Dedehayir. Business ecosystem evolution and strategic considerations: A literature review. In *Engineering, Technology and Innovation (ICE), 2012 18th International ICE Conference on*, pages 1–10. IEEE, 2012.

[7] Nicolò Paternoster, Carmine Giardino, Michael Unterkalmsteiner, Tony Gorschek, and Pekka Abrahamsson. Software development in startup companies: A systematic mapping study. *Information and Software Technology*, 56(10):1200–1218, 2014.

[8] Eriks Klotins, Michael Unterkalmsteiner, and Tony Gorschek. Software engineering knowledge areas in startup companies: a mapping study. In *International Conference of Software Business*, pages 245–257. Springer, 2015.

[9] Rodney T. Ogawa and Betty Malen. Towards rigor in reviews of multivocal literatures: Applying the exploratory case study method. *Review of Educational Research*, 61(3):265–286, 1991.

[10] Vahid Garousi, Michael Felderer, and Mika V. Mäntylä. The need for multivocal literature reviews in software engineering: complementing systematic literature reviews with grey literature. In *Proceedings of the 20th International Conference on Evaluation and Assessment in Software Engineering*, page 26. ACM, 2016.

[11] Steve Blank and Bob Dorf. *The startup owner's manual: The step-by-step guide for building a great company*. BookBaby, 2012.

[12] Eric Ries. *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. Crown Books, 2011.

[13] Mark Crowne. Why software product startups fail and what to do about it. evolution of software product development in startup companies. In *Engineering Management Conference, 2002. IEMC'02. 2002 IEEE International*, volume 1, pages 338–343. IEEE, 2002.

[14] Steve Blank. *The four steps to the epiphany: successful strategies for products that win*. BookBaby, 2013.

[15] Xiaofeng Wang, Henry Edison, Sohaib S. Bajwa, Carmine Giardino, and Pekka Abrahamsson. Key challenges in software startups across life cycle stages. In *International Conference on Agile Software Development*, pages 169–182. Springer, 2016.

[16] Nirnaya Tripathi, Pertti Seppänen, Markku Oivo, Jouni Similä, and Kari Liukkunen. The effect of competitor interaction on startup's product development. In *Software Engineering and Advanced Applications (SEAA), 2017 43rd Euromicro Conference on*, pages 125–132. IEEE, 2017.

[17] Pertti Seppänen, Nirnaya Tripathi, Markku Oivo, and Kari Liukkunen. How are product ideas validated? In *International Conference of Software Business*, pages 3–17. Springer, 2017.

[18] James F. Moore. *The death of competition: leadership and strategy in the age of business ecosystems*. Harper Paperbacks, 1997.

[19] Jan Bosch and Petra Bosch-Sijtsema. From integration to composition: On the impact of software product lines, global development and ecosystems. *Journal of Systems and Software*, 83(1):67–76, 2010.

[20] Slinger Jansen, Anthony Finkelstein, and Sjaak Brinkkemper. A sense of community: A research agenda for software ecosystems. pages 187–190, 2009.

[21] Konstantinos Manikas. Revisiting software ecosystems research: A longitudinal literature study. *Journal of Systems and Software*, 117:84–103, 2016.

[22] Daniel Cukier, Fabio Kon, and LS Thomas. Software startup ecosystems evolution: The new york city case study. In *Proceedings 2nd International Workshop on Software Startups*, 2016.

[23] Aleksi Aaltonen. Factors shaping entrepreneurial ecosystems and the rise of entrepreneurship: A view from top management journals. `http://www.demoshelsinki.fi/wp-content/uploads/2016/06/Aaltonen-Factors-shaping-entrepreneurial-ecosystems.pdf`, 2016. [accessed November 1, 2016].

[24] Nagila N. Torres and Cleidson R. Souza. A literature review about technology startups ecosystems. In *Proceedings of the XII Brazilian Symposium on Information Systems on Brazilian Symposium on Information Systems: Information Systems in the Cloud Computing Era-Volume 1*, page 51. Brazilian Computer Society, 2016.

[25] Staffs Keele. *Guidelines for performing systematic literature reviews in software engineering*. Technical report, Ver. 2.3 EBSE Technical Report. EBSE. 2007.

[26] Kai Petersen, Robert Feldt, Shahid Mujtaba, and Michael Mattsson. Systematic mapping studies in software engineering. In *EASE*, volume 8, pages 68–77, 2008.

[27] Claes Wohlin. Guidelines for snowballing in systematic literature studies and a replication in software engineering. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering*, page 38. ACM, 2014.

[28] Mathieu Templier and Guy Paré. A framework for guiding and evaluating literature reviews. *Communications of the Association for Information Systems*, 37, 2015.

[29] Sohaib S. Bajwa, Xiaofeng Wang, Anh N. Duc, and Pekka Abrahamsson. "failures" to be celebrated: an analysis of major pivots of software startups. *Empirical Software Engineering*, pages 1–36, 2016.

[30] Konstantinos Manikas and Klaus M. Hansen. Software ecosystems–a systematic literature review. *Journal of Systems and Software*, 86(5):1294–1306, 2013.

[31] Nirnaya Tripathi, Elina Annanperä, Markku Oivo, and Kari Liukkunen. Exploring processes in small software companies: A systematic review. In *International Conference on Software Process Improvement and Capability Determination*, pages 150–165. Springer, 2016.

[32] Daniel Cukier, Fabio Kon, and Norris Krueger. Designing a maturity model for software startup ecosystems. In *International Conference on Product-Focused Software Process Improvement*, pages 600–606. Springer, 2015.

[33] Bharat Rao and Bertha Jimenez. A comparative analysis of digital innovation ecosystems. In *Technology Management in the Energy Smart World (PICMET), 2011 Proceedings of PICMET'11:*, pages 1–12. IEEE, 2011.

[34] Ruixue Xia, Mattias Rost, and Lars E. Holmquist. Business models in the mobile ecosystem. In *Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR), 2010 Ninth International Conference on*, pages 1–8. IEEE, 2010.

[35] India startup ecosystem timeline. `https://en.wikipedia.org/wiki/India_Startup_Ecosystem_TimeLine`, 2016. [accessed November 1, 2016].

[36] Daniel Cukier, Fabio Kon, and Norris Krueger. Designing a maturity model forsoftware startup ecosystems. `https://www.researchgate.net/publication/283352688_Designing_a_Maturity_Model_for_Software_Startup_Ecosystems`, 2015. [accessed November 1, 2016].

[37] Daniel Cukier, Fabio Kon, and Norris Krueger. Towards a software startup ecosystems maturity model. `http://ccsl.ime.usp.br/startups/files/MaturityModelTechReport_0.pdf`, 2015. [accessed November 1, 2016].

[38] Roel Wieringa, Neil Maiden, Nancy Mead, and Colette Rolland. Requirements engineering paper classification and evaluation criteria: a proposal and a discussion. *Requirements Engineering*, 11(1):102–107, 2006.

[39] Mary Shaw. Writing good software engineering research papers. In *Software Engineering, 2003. Proceedings. 25th International Conference on*, pages 726–736. IEEE, 2003.

[40] Martin Ivarsson and Tony Gorschek. A method for evaluating rigor and industrial relevance of technology evaluations. *Empirical Software Engineering*, 16(3):365–395, 2011.

[41] Edith Tom, AybüKe Aurum, and Richard Vidgen. An exploration of technical debt. *Journal of Systems and Software*, 86(6):1498–1516, 2013.

[42] Daniela S. Cruzes and Tore Dyba. Recommended steps for thematic synthesis in software engineering. In *Empirical Software Engineering and Measurement (ESEM), 2011 International Symposium on*, pages 275–284. IEEE, 2011.

[43] Vaida Pilinkien and Povilas Mačiulis. Comparison of different ecosystem analogies: The main economic determinants and levels of impact. *Procedia-social and behavioral sciences*, 156:365–370, 2014.

[44] Safwan Mchawrab. M&a in the high tech industry: value and valuation. *Strategic Direction*, 32(6):12–14, 2016.

[45] Heidi M. Neck, G. D. Meyer, Boyd Cohen, and Andrew C. Corbett. An entrepreneurial system view of new venture creation. *Journal of Small Business Management*, 42(2):190–208, 2004.

[46] Per Runeson and Martin Höst. Guidelines for conducting and reporting case study research in software engineering. *Empirical software engineering*, 14(2):131, 2009.

[47] Xin Zhou, Yuqin Jin, He Zhang, Shanshan Li, and Xin Huang. A map of threats to validity of systematic literature reviews in software engineering. In *Software Engineering Conference (APSEC), 2016 23rd Asia-Pacific*, pages 153–160. IEEE, 2016.

[48] F Kon, D Cukier, C Melo, O Hazzan, and H Yuklea. A conceptual framework for software startup ecosystems: the case of israel. *Department of Computer Science, University of São Paulo, Tech. Rep. RT-MAC-2015-01*, 2015.