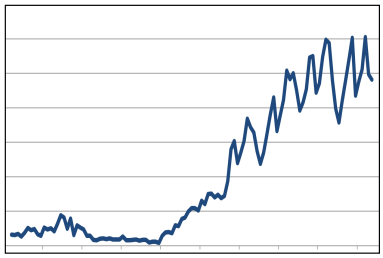
Technology Innovation Management Review

July 2017
Volume 7 Issue 7



TIM Review Readership (McPhee et al., 2017)

10th Anniversary Issue

Welcome to the July issue of the *Technology Innovation Management Review*. We welcome your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

Carleton UNIVERSITY

www.timreview.ca

Technology Innovation Management Review

July 2017
Volume 7 Issue 7

Publisher

The *Technology Innovation Management Review* is a monthly publication of the Talent First Network.

ISSN

1927-0321

Editor-in-Chief

Chris McPhee

www.timreview.ca

Overview

The *Technology Innovation Management Review* (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

We welcome input from readers into upcoming themes. Please visit timreview.ca to suggest themes and nominate authors and guest editors.

Contribute

Contribute to the TIM Review in the following ways:

- Read and comment on articles.
- Review the upcoming themes and tell us what topics you would like to see covered.
- Write an article for a future issue; see the author guidelines and editorial process for details.
- Recommend colleagues as authors or guest editors.
- Give feedback on the website or any other aspect of this publication.
- Sponsor or advertise in the TIM Review.
- Tell a friend or colleague about the TIM Review.

Please contact the Editor if you have any questions or comments: timreview.ca/contact

About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: 10th Anniversary Issue

Chris McPhee, Editor-in-Chief

Welcome to the July 2017 issue of the *Technology Innovation Management Review* (TIM Review), which marks the 10th anniversary issue of this journal. The authors in this issue share insights on the history of the TIM Review, urban living labs, inclusive innovation, entrepreneurial ecosystems in India, and knowledge commercialization by universities. In addition to offering insights on diverse topics spanning the journal's scope, with contributions from the Americas, Asia, Europe, and Oceania, the authors in this anniversary issue reflect the international diversity that has become a key feature of the TIM Review over the past 10 years.

In the first article, **Teemu Santonen** from Laurea University of Applied Sciences in Finland, **Ahmed Shah** and **Ali Nazari** from Carleton University's Global Cybersecurity Resource in Ottawa, Canada, and I reflect on the 10-year publication history of the TIM Review. We use topic modelling to discover and analyze the journal's seven themes – open source business, technology entrepreneurship, growing a business, research approaches, social innovation, living labs, and cybersecurity – and how they have changed over time. We trace the history of the journal, summarize its distinctive features, and evaluate the growth in its readership and the evolution of its author community.

The second article is by **Kris Steen** and **Ellen van Bueren** from the Amsterdam Institute for Advanced Metropolitan Solutions in the Netherlands, who examine the living labs literature published in the TIM Review and elsewhere to develop an operationalized definition of urban living labs. They also examine 90 urban innovation projects in Amsterdam that are labelled as "living labs" to assess whether they are indeed undertaking the defining co-creation and development activities of living labs. Their goal is to develop a general framework to help identify which projects represent "real" urban living labs, both to enable researchers to apply more specific analyses and to help the projects themselves achieve the innovation potential of the living lab approach.

Then, **Sandra Schillo** and **Ryan Robinson** from the University of Ottawa in Canada summarize the origins of the concept of inclusive innovation and argue that innovation needs to be inclusive in terms of people, activities, outcomes, and governance. Based on these four dimensions, they propose a framework intended to guide policy development and encourage academics to investigate all dimensions of inclusive innovation in developed countries.

Next, **M H Bala Subrahmanya** from the Indian Institute of Science in Bangalore, India, compares the entrepreneurial ecosystems in Bangalore and Hyderabad, which are designed to encourage innovation, spur the development of new products and services, and generate employment through entrepreneurship. By comparing the evolution, structure, and components of the two ecosystems, Subrahmanya derives key lessons for others within and beyond India.

Finally, **Mohammad Saud Khan** from Victoria University of Wellington, New Zealand, answers the question: "Are universities ready for knowledge commercialization?" With case examples, Khan highlights the persistent and critical challenges that universities must overcome in light of their increasing role in knowledge transfer and commercialization. He argues for a diversified approach that includes joint research ventures and university spin-offs but that combines and develops new mechanisms and policies. He also highlights the need for strategic plans that take a long-term view and a adopt a commercial mentality that considers the broader business ecosystems, including actors beyond the university context.

For future issues, we are accepting general submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and growing technology companies and solving practical problems in emerging domains. Please contact us (timreview.ca/contact) with potential article topics and submissions.

Chris McPhee
Editor-in-Chief

Editorial: 10th Anniversary Issue

Chris McPhee

About the Editor

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. He holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa, Canada, and BScH and MSc degrees in Biology from Queen's University in Kingston, Canada. Chris has nearly 20 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

Citation: McPhee, C. 2017. Editorial: 10th Anniversary Issue. *Technology Innovation Management Review*, 7(7) 3–4. http://timreview.ca/article/1086

Keywords: TIM Review, OSBR, topic modelling, urban, living labs, inclusive innovation, entrepreneurship, ecosystems, India, knowledge commercialization, universities

Reflecting on 10 Years of the TIM Review

Chris McPhee, Teemu Santonen, Ahmed Shah, and Ali Nazari

> "*Fare forward, you who think that you are voyaging;*"
> *You are not those who saw the harbour*
> *Receding, or those who will disembark.*
> *Here between the hither and the farther shore*
> *While time is withdrawn, consider the future*
> *And the past with an equal mind.*
>
> T. S. Eliot (1888–1965)
> Poet, dramatist, and literary critic
> In *The Dry Salvages* (1941)

In July 2007, the first issue of this journal was published under the banner of the *Open Source Business Resource.* Re-launched with a broader scope in 2011 as the *Technology Innovation Management Review,* the journal now celebrates its 10th anniversary. In this article, we review the 10-year history of the journal to examine what themes have been covered, who has contributed, and how much the articles have been read and cited. During those 10 years, the journal has published 120 monthly issues, including more than 800 publications by more than 800 international authors from industry, academia, the public sector, and beyond. As discovered with topic modelling, the journal has covered seven themes: open source business, technology entrepreneurship, growing a business, research approaches, social innovation, living labs, and cybersecurity. Overall, the website has attracted over 1 million readers from around the world – 31% from Asia, 30% from the Americas, 26% from Europe, 8% from Africa, and 5% from Oceania – with over 25,000 readers now accessing the site each month.

Introduction

For the past 10 years, this journal has published monthly issues on the theories, strategies, and tools relevant to launching and growing technology businesses. In seeking to bring together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – the *Technology Innovation Management Review* (TIM Review) has tried to bridge the gap between theory and practice. The journal's aim is to provide significant benefits to readers, authors, guest editors, partners, and stakeholders worldwide.

In this article, we trace the evolution of the journal by analyzing its distinct aspects, the topics it covered, the authors that contributed to it, and the extent to which its articles were read and cited. Our goals are to share with others the lessons learned and to use these lessons to inform the future directions of the journal.

A Brief History of the TIM Review

Ten years ago, this journal was launched as part of a government program "to help business innovators take their products to market" (DeFoe, 2007). With financial support from the Ontario Ministry of Research and Innovation and led by the Technology Innovation Management (TIM) Program (timprogram.ca) at Carleton University in Ottawa, Canada, the journal was a key component of a province-wide project to encourage research commercialization and knowledge transfer, initially within Ontario, then to the rest of Canada, and then worldwide.

The goal of the government program was to spur economic development in Ontario by helping its researchers and entrepreneurs "to combine their expertise to help commercialize their innovations and create high-value jobs" (DeFoe, 2007). Carleton University's project – the Talent First Network – sought to develop and

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transfer "knowledge about how businesses can use open source assets and processes to generate revenue and reduce costs" (Bailetti, 2007). The project leads decided that a monthly journal appealing to a cross-section of relevant audiences could help develop and disseminate relevant knowledge to help companies compete in emerging technology-based domains (Bailetti, 2007). Thus, this journal was launched in July 2007 by its founding Editor-in-Chief, Dru Lavigne, as the *Open Source Business Resource* (OSBR). As its focus, the journal sought to answer the question of how to make money with something that is free: to explore the business side of open source (McPhee, 2011). However, the choice to focus on open source software was more about developing understanding and capability within a new competitive environment that it was about free software (Bailetti, 2007).

As open source became "a better-understood, mainstream tool for technology businesses" (McPhee, 2011) and continuing with the mid-2010 appointment of a new Editor-in-Chief, the journal began to broaden and shift its scope towards technology entrepreneurship and innovation management in addition to open source business. After publishing 50 monthly issues as the OSBR (McPhee, 2011), this gradual change was formalized in the re-launch of the journal as the *Technology Innovation Management Review* in October 2011. The scope and audience of the journal broadened, but the focus remained fixed on developing and disseminating knowledge about the issues and emerging trends relevant to launching and growing technology businesses. The journal published its 100th issue in 2015 (McPhee, 2015) and now celebrates its 10th anniversary in July 2017.

Format and Scope

Distinctive features
The following features have distinguished the journal through its 10-year history:

1. *Free to readers and authors:* To encourage a diversity of readers and authors, and to remove financial barriers to access or contribution, the journal is online and fully open access and no fees are charged to authors, despite a rigorous peer review process and a high level of editorial support. Authors also retain copyright of their work, which is published in the journal under a Creative Commons Attribution licence (CC-BY; creativecommons.org/licenses/by/3.0/). Readers are encouraged to share and build upon the insights published in the journal.
2. *Monthly issues with short publication timescales:* The journal is published monthly with publication timelines of three to four months, which may be normal or even long for most practitioner publications but are short for most academic publications. The intention (and challenge) is to provide a steady flow of insights at the pace of business while still meeting the requirements of academic contributors.
3. *Themed issues:* In most issues, the journal brings together authors who can provide diverse perspectives on a theme. The journal now also publishes regular (unthemed) issues of articles fitting the overall scope of the journal.
4. *Guest editors:* Guest editors play a key role in defining the vision for themed issues and recruiting high-quality authors to contribute. Through their networks, the journal is able to access new areas of expertise and efficiently grow its community.
5. *Practical implications:* Given the focus on the theories, strategies, and tools that help small and large technology companies succeed, authors are required to emphasize the practical implications of their work.
6. *Diversity:* The journal is designed to bring together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice.
7. *Rigorous editorial process:* All articles published in the journal are peer reviewed using a double-blind process. Regardless of whether they represent industry or academia, authors undergo the same process and write using the same format. The intention is to bring diverse authors together to share insights and to avoid segregating audiences based on article format. Although practitioners must provide adequate support and explanation for any assertions or shared insights, they are not expected to draw upon academic sources. Publications based on research must meet high standards for methodology and analysis while also making the results and their implications accessible to a diverse audience that includes non-academics.
8. *Author support:* Following peer review and revision, authors whose articles have been accepted receive unique value in the form of editorial support, which goes far beyond copyediting and proofreading to include advice and recommendations on how to im-

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prove their articles, particularly to ensure it will be accessible to diverse readers. This editorial support is provided free of charge to improve the quality of the journal but also to extend its international reach, particularly to authors whose first language is not English.

9. *Emphasis on emerging topics:* The journal was founded based on a need to understand an emerging domain (open source business), and this remains an emphasis. The journal provides guest editors, authors, and readers with opportunities to explore emerging areas, where there may be more questions than answers.

Types of content

In all, there have been 795 publications in the TIM Review up to and including the May 2017 issue (Table 1), which is the timeframe used for most analyses in this article. In each monthly issue of the journal, the Editor-in-Chief and the Guest Editors contribute an editorial to introduce that issue's editorial theme and give notice of upcoming issues and events. These editorials represent 15% (118) of all publications. Articles, however, form the core of the TIM Review content: this publication type has accounted for almost 75% (590) of all content published in the journal (Table 1). Less commonly, authors write shorter, less formal pieces focusing on a single practical question: these 39 "Q&As" account for about 5% of the content. Finally, 6% of the content takes the form of 48 summaries from the TIM Lecture Series at Carleton University, which is hosted by the TIM Program. The TIM Lectures provide a forum to promote the transfer of knowledge between university research to technology company executives and entrepreneurs as well as research and development personnel. The lecture subjects mirror areas of interest to the academic program, which are also reflected in the scope of the journal, and both have evolved in parallel over the 10-year history of the journal.

Table 1. Distribution of number of publications by publication type

	Article	Editorial	Lecture	Q&A	Total
Number	590	118	48	39	795
Share	74%	15%	6%	5%	100%

Themes

To examine the text of 10 years of TIM Review articles, we used topic modelling, which is a text-mining technique for discovering themes in a large collection of documents (Blei, 2012). The technique assumes that documents are "mixtures of topics", where a topic is a group of words that frequently occur together (McCallum, 2002; Steyvers & Griffiths, 2007). Even when documents are labelled or dominant topics are well known, topic modelling can help discover hidden patterns or provide additional structure to organize, search, navigate, or summarize large collections of documents. The two key outputs of generating a topic model on a collection of documents are: i) a list of topics (i.e., groups of words that frequency occurs together) and ii) lists of the documents that are strongly associated with each of the topics. Ideally, groups of documents that are identified as highly associated with a given topic should be related to each other, and each topic should be distinguishable from other topics.

To generate a topic model for the TIM Review, we used "MALLET: A Machine Learning for Language Toolkit" (mallet.cs.umass.edu), which is open source software developed by Andrew McCallum and other contributors at the University of Massachusetts and the University of Pennsylvania (McCallum, 2002). We pre-processed the text data by defining a list of "stop words" (i.e., familiar words to be ignored in the analysis such as "a", "and", "the", "etc.", "TIM", "review", and "author"), stemming the text (i.e., treating "agent" and "agents" as the same word), and joining multi-word terms (e.g., converting "living labs" and "supply chain" to "living_labs" and "supply_chain").

Here, we report the results obtained when generating seven topics in the topic modelling algorithm. Each topic is represented by a set of words that describe the topic and degree to which individual publications are associated to it. Based on our interpretation of these sets of words and our knowledge of the documents associated with each of them, we inferred and applied a subjective label, or "theme", to each of the seven topics identified by the algorithm.

Table 2 lists the seven themes along with their topic words, which are the 20 words that are most likely to occur in publications within that topic. The subsections that follow discuss each of the discovered themes and their associated content (i.e., issues and articles), including results examining the topics over time, which

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Table 2. The seven themes of the TIM Review from 2007 to 2017 and their associated topic words, as discovered using topic modelling

Theme	Topic Words
1. Open Source Business	open source, software, project, community, open, user, code, license, source, developer, development, application, oss, system, support, commercial, f/loss, free, proprietary, tool
2. Technology Entrepreneurship	entrepreneur, technology, business, startup, patent, university, global, firm, research, program, innovation, venture, company, woman, growth, market, knowledge, development, student, opportunity
3. Growing a Business	business, company, customer, service, product, model, market, process, firm, technology, ecosystem, innovation, platform, organization, management, development, solution, strategy, capability, resource
4. Research Approaches	research, entrepreneur, study, ecosystem, creative, process, network, relationship, theory, firm, actor, knowledge, game, analysis, context, activity, employee, behavior, social, individual
5. Social Innovation	social, people, community, work problem, idea, organization, time world, group, project, experience, team, challenge, health, change, support, individual, member, solution
6. Living Labs	Innovation, living lab, research, user, process, project, knowledge, service, case, development, open, study, network, activity, stakeholder, co-creation, city, design, region, context
7. Cybersecurity	data, security, system, information, cybersecurity, device, risk, infrastructure, network, technology, control, mobile, cloud, threat, internet, access, research, application, critical, vulnerability

allowed us to track the evolving importance of the seven identified themes over the 10-year publishing record of the TIM Review. Figures 1 to 7 show the monthly changes in each theme, including a fitted line to summarize the overall trend.

1. Open Source Business

For this topic, the model returned words commonly associated with open source and its intersection with business, such as "open source" (and related terms), "license", "proprietary", "free", and "commercial" (Table 2). Given the history of the journal, it is expected that the emphasis on the "Open Source Business" theme would decrease over time, and this trend is reflected in the results (Figure 1). Although open source business was the dominant theme in the journal's early history, it is now rarely covered. The business aspects of open source shifted from being a thread that ran through most of the journal's early publications to a subject that was addressed in recurring special issues specifically dedicated to open source business in January of 2011, 2012, 2013, and 2014, as indicated in Figure 1.

2. Technology Entrepreneurship

The theme of "Technology Entrepreneurship" is relevant throughout the 10 years of the journal. It relates to the business side of open source, as reflected by its minor presence in early articles, but it was given greater emphasis from 2010 onwards (Figure 2), particularly in the early issues following the re-launch of the TIM Review. Notably, four consecutive issues on Technology Entrepreneurship were published in early 2012 (see Bailetti et al., 2012 for an overview of the four issues), and the several articles in these issues have played a key role in the subsequent growth of the journal, as will be discussed later.

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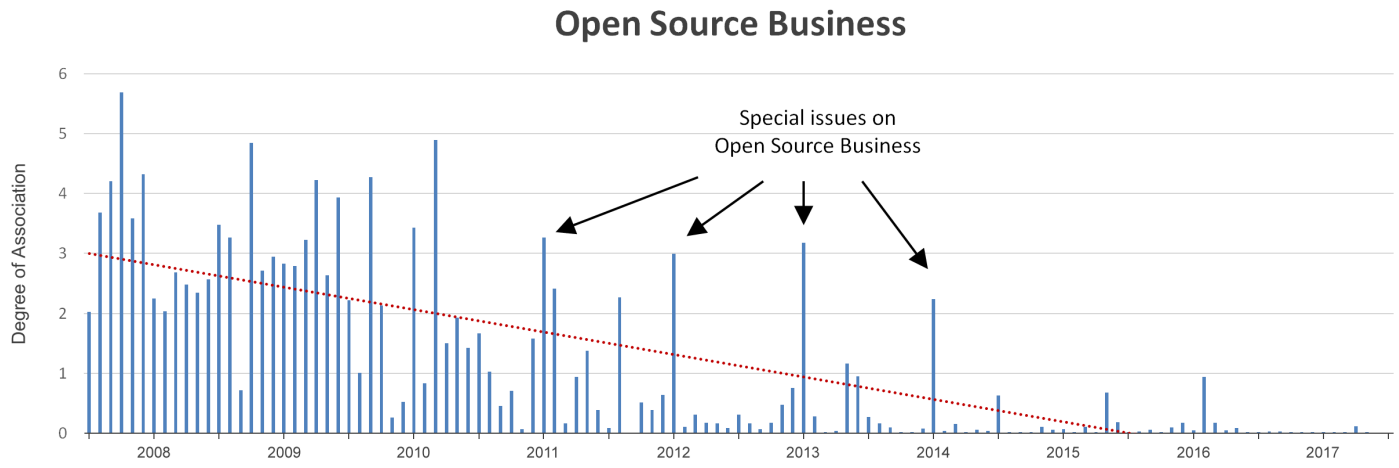

Figure 1. Tracking the "Open Source Business" theme in the OSBR and TIM Review (2007–2017) with key special issues marked

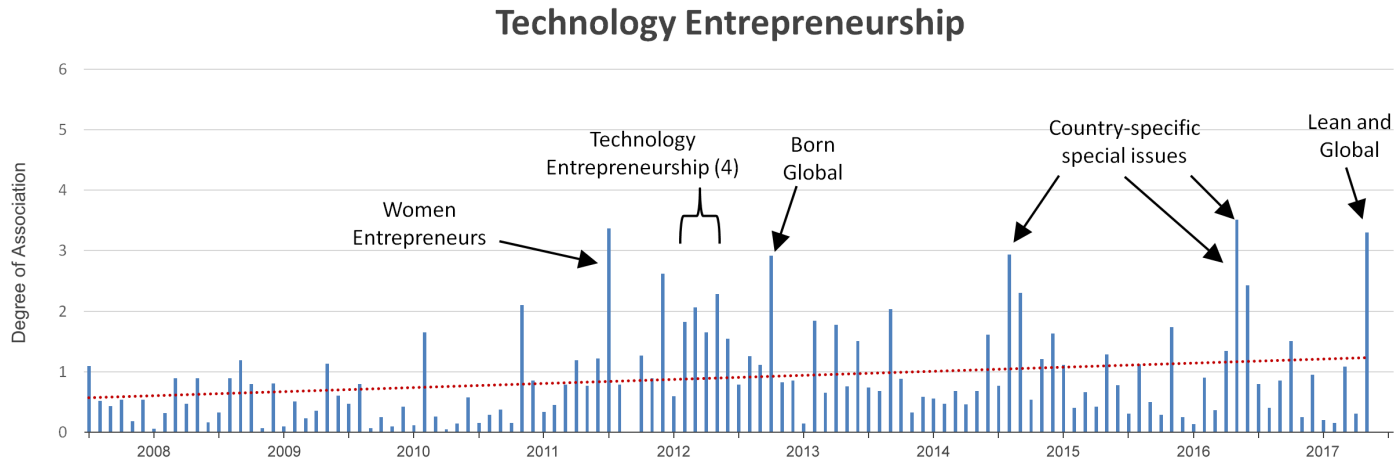

Figure 2. Tracking the "Technology Entrepreneurship" theme in the OSBR and TIM Review (2007–2017) with key special issues marked

Other articles that have strong associations to this theme have come from special issues:

- An issue on Women Entrepreneurs in July 2011.
- Issues on the global aspects of entrepreneurship, such as Born Global in October 2012 and Lean and Global in May 2017.
- Issues focusing on entrepreneurship and innovation in particular countries, such as India in August 2014 and May 2016 and Australia in June 2016.

Aside from publications within these dedicated special issues, many other articles are associated with the theme of Technology Entrepreneurship, particularly since the re-launch of the journal.

3. Growing a Business

Articles associated with the theme of "Growing a Business" cover processes, methods, strategies, and other aspects relating to the practical aspects of launching and growing technology businesses, such as developing business models, platforms and business ecosystems, products and services, customers, capabilities, and markets. Although not strongly associated with any special issues or particular efforts in this regard (Figure 3), they highlight the journal's emphasis on the practical implications of the articles, whether they come from academic authors, industry authors, or others.

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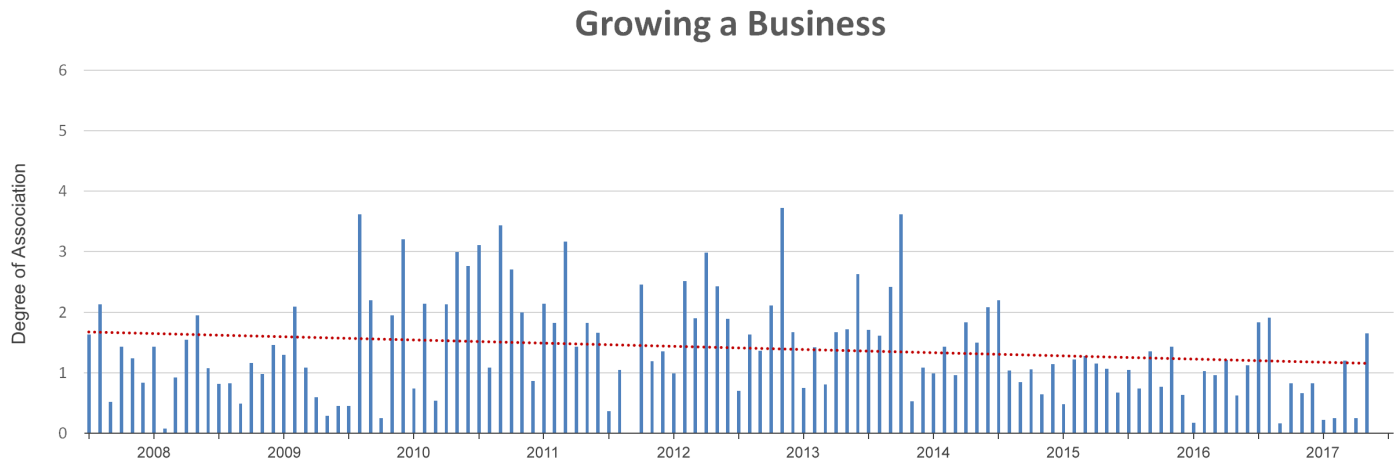

Figure 3. Tracking the "Growing a Business" theme in the OSBR and TIM Review (2007–2017)

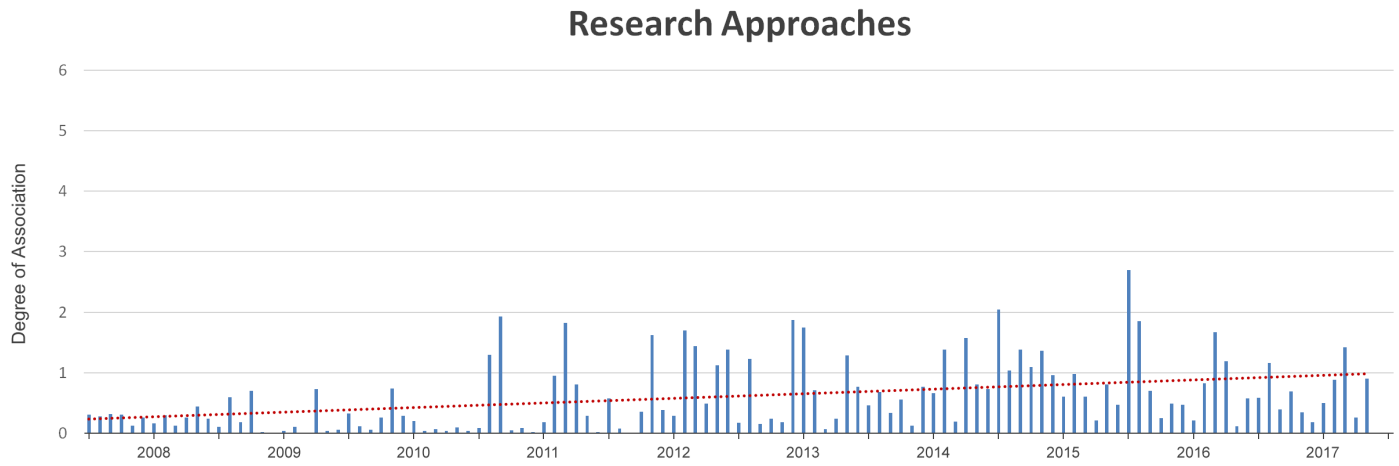

Figure 4. Tracking the "Research Approaches" theme in the OSBR and TIM Review (2007–2017)

4. Research Approaches

In contrast to the "Growing a Business" theme, the "Research Approaches" theme emphasizes an academic view of technology innovation management. The degrees of association are lower in magnitude than the other themes (contrast Figure 4 to the other related figures), but this theme's increasing emphasis reflects both greater attention to this area following the relaunch of the journal and the journal's increasingly academic perspective. However, the articles associated with this theme also represent a bridging of theory and practice given they seek to identify the research questions, trends, and approaches that will best support technology companies.

5. Social Innovation

Throughout the 10 years, the journal has published many articles with a strong social innovation element. Indeed, tracking the "Social Innovation" theme over time (Figure 5) highlights contributions from several special issues related to social issues, including:

- Social Innovation in September 2008 and July 2012.
- Women in Open Source in June 2009 and, to a lesser degree, Women Entrepreneurs in July 2011.
- Humanitarian Open Source in December 2010.

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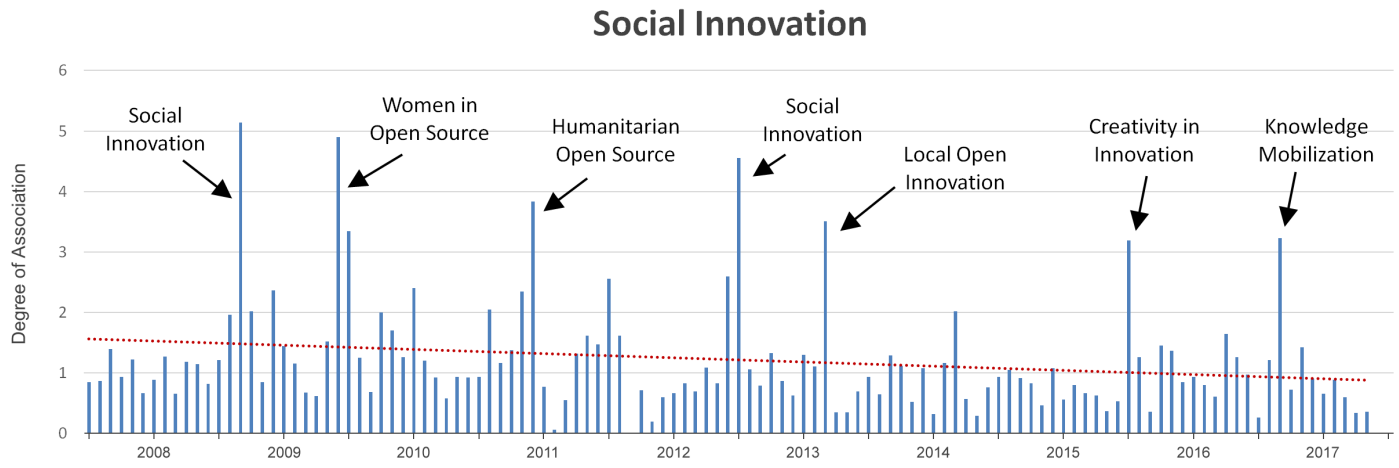

Figure 5. Tracking the "Social Innovation" theme in the OSBR and TIM Review (2007–2017) with key special issues marked

More recently, however, articles from several special issues on innovation have shown associations with this theme, likely because of a terminology overlap and common ideas around building relationships and communities, considering all viewpoints and bringing people together to contribute ideas, share knowledge, etc. These shared concepts may explain the associations from articles associated with the following special issues and contributions:

- Articles related to community building, which is a particularly important concept in open source projects.
- Articles related to collaboration and open innovation approaches, including an issue on Local Open Innovation in March 2013.
- A special issue on Creativity in Innovation in July 2015.
- A special issue on Knowledge Mobilization in September 2016.

6. Living Labs

A particularly prominent theme in the TIM Review has been "Living Labs", which has featured in seven special issues beginning in September 2012 (Figure 6). The prominence of this theme and the special issues was triggered and driven by the appointment of Mika Westerlund to the TIM Program in July 2012; his recurring collaborations with co-guest editors Seppo Leminen, Dimitri Schuurman, Pieter Ballon, and Eelko Huizingh; and the journal's partnerships with the European Network of Living Labs (ENoLL; openlivinglabs.eu) and the International Society for Professional Innovation Management (ISPIM; ispim-innovation.com), which are discussed below.

Given the conceptual overlap, the theme of Living Labs also includes associations from non-living-lab articles that focus on co-creation, open innovation, and service innovation, which are recurring subjects in the TIM Review.

Finally, note that the TIM Review archive of articles on the subject of living labs has been reviewed recently as part of efforts to develop a framework of the defining characteristics of *urban* living labs (Steen & van Bueren, 2017), which is featured in the same issue as the present article.

7. Cybersecurity

The seventh theme emerging from topic modelling the TIM Review's 10-year database is "Cybersecurity". Although some early articles are associated with cybersecurity through its relevance to open source software, the theme truly emerges more recently through the journal's partnerships with the VENUS Cybersecurity Corporation (which was first announced in the TIM Review: see Bailetti et al., 2013), Canada's Communications Security Establishment (CSE), and Carleton University's Global Cybersecurity Resource (GCR). These partnerships have also led to a new initiative to develop topic modelling and machine learning tools to discover and explore topics in the TIM Review, and the current analyses represent only an initial step towards this capability. Since July 2013, the TIM Review has published 9 special issues on Cybersecurity (Figure 7).

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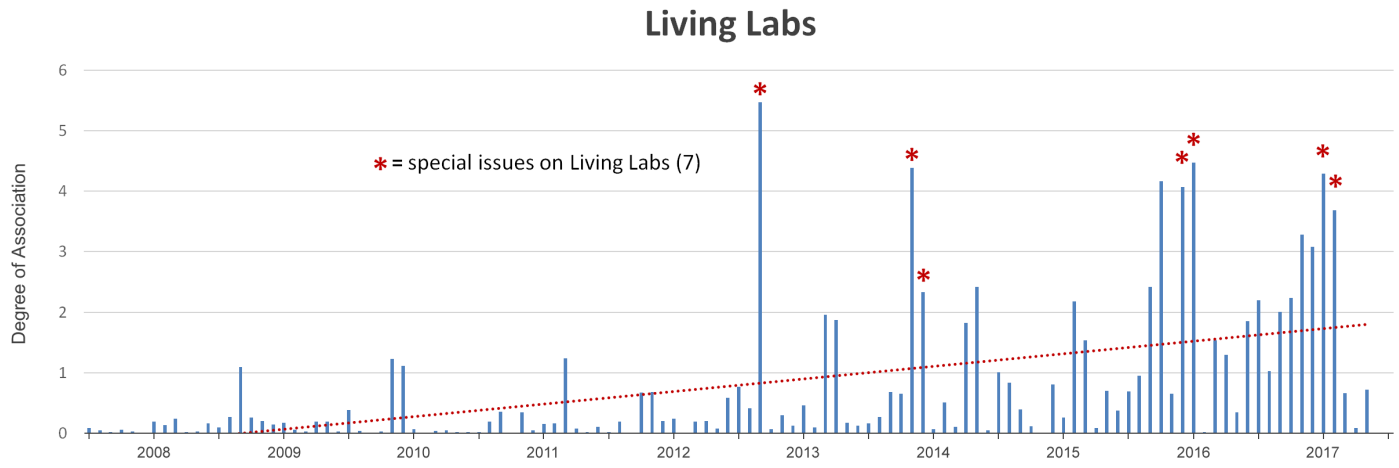

Figure 6. Tracking the "Living Labs" theme in the OSBR and TIM Review (2007–2017) with key special issues marked

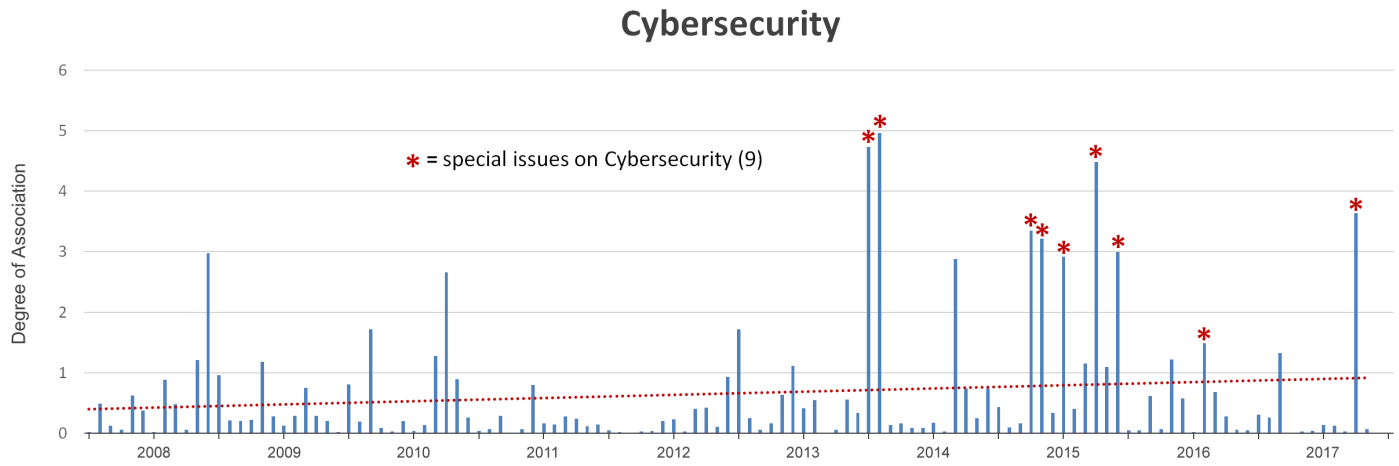

Figure 7. Tracking the "Cybersecurity" theme in the OSBR and TIM Review (2007–2017) with key special issues marked

Contributors

Evolution of the contributor community

As of May 2017 (the endpoint of our analyses for this article), the TIM Review community included 818 different authors. Figure 8 shows the number of new authors per year and the cumulative size of the author community for each year, excluding the incomplete current year (2017). On average, the author community has expanded by 83 authors each year, although the rate of annual growth has increased in recent years (correlation 0.756*, sig. 0.011 when 2017 is excluded from analysis). However, less than 3% of authors (N=22) have published in both the OSBR and TIM Review, and most of them (N=12) have either TIM affiliation (i.e., they are a TIM student, TIM faculty, or TIM adjunct) or have acted as an editor (N=10 when editors are included and N=6 when TIM affiliations are excluded). In all, the OSBR gained 304 authors (37%) and the TIM Review gained 514 authors (63%). Basically, these findings indicate that the author community underwent a nearly complete transformation following the re-launch of the journal. When articles about open source business were published following the re-launch, they tended to arise from within the TIM Program, reflecting the retention of expertise and interest in this topic among faculty and students. Moreover, the shift in scope from the OSBR and TIM Review mirrored the evolving research and teaching topics in the TIM Program, which further explains why the authors that bridged the two iterations of the journal were predominantly from the journal's associated academic program. However, the

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re-launch of the journal allowed new areas of existing networks to step forward and created opportunities for new contributors, including international guest editors, authors, and partners.

This recent increase in growth is partially associated with an increase in the number of articles contributed by multiple authors. The number of authors is positively correlated (0.377**, sig. 0.000) with creation year. There is a very strong negative correlation (N=11, -0.958**, sig. 0.000) in single-author publications, and there are strong positive correlations for articles having two authors (0.788**, sig. 0.004), four authors (0.727*, sig. 0.011) and five or more authors (0.918**, sig. 0.000). In the early years, single-author publications represented about 80% of the articles, but by 2017, this share had dropped to around 25%. However, the profiles between the two eras of the journal are different. In the case of the OSBR, there is no correlation between the number of authors and publication year, whereas the TIM review keeps the positive correlation (0.212**, sig. 0.000). The very strong negative correlation remains within TIM Review (N=6, -0.957**, sig. 0.003) in single-author publications as well as for three authors (0.867*, sig. 0.025) and five or more authors (0.872*, sig. 0.023). In the case of the OSBR, there are no correlations. In light of the increasingly international reach of the TIM Review since the re-launch, the tendency to favour larger co-author teams is not a surprise: it is in line with prior suggestions from Santonen and Ritala (2014), who viewed a trend of increasing co-authorship as an indicator of increased knowledge sharing and creation, as a result of the collaboration that co-authorship requires (Newman, 2004).

Contributor origins and roles

TIM review authors represent 33 countries, which break down by continent as shown in Figure 9. As reported at the time of the re-launch (McPhee, 2011), 85% of OSBR authors were from Canada or the United States, but over the entire 10-year period, the continent of the Americas represents 56% of the overall author community (Figure 9), with an increasing representation of European authors accounting for most of the change (12% vs. 36%). Table 3 lists the top 10 countries by author and readers, further highlighting the European contributions with six out of the top 10 countries for authors being from Europe.

Table 3. Top 10 countries by TIM Review authors and readers

	Authors		Readers
1.	Canada	1.	United States
2.	United States	2.	India
3.	Finland	3.	Canada
4.	Germany	4.	United Kingdom
5.	Australia	5.	Australia
6.	Belgium	6.	Malaysia
7.	United Kingdom	7.	Philippines
8.	Denmark	8.	Germany
9.	India	9.	Netherlands
10.	Sweden	10.	Kenya

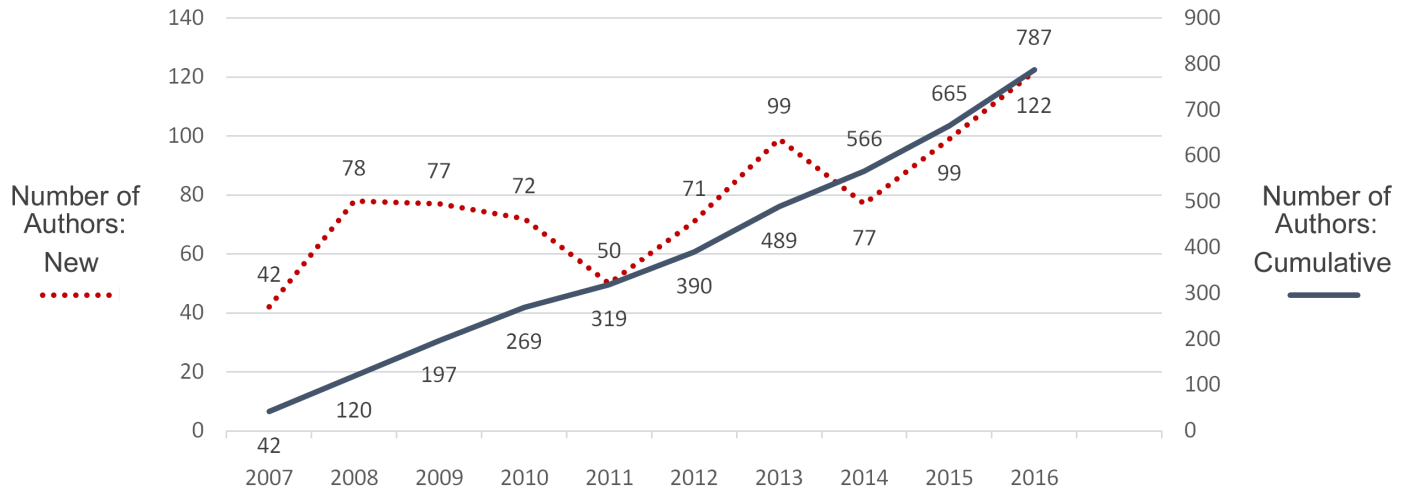

Figure 8. Growth of the TIM Review author community per year and cumulatively

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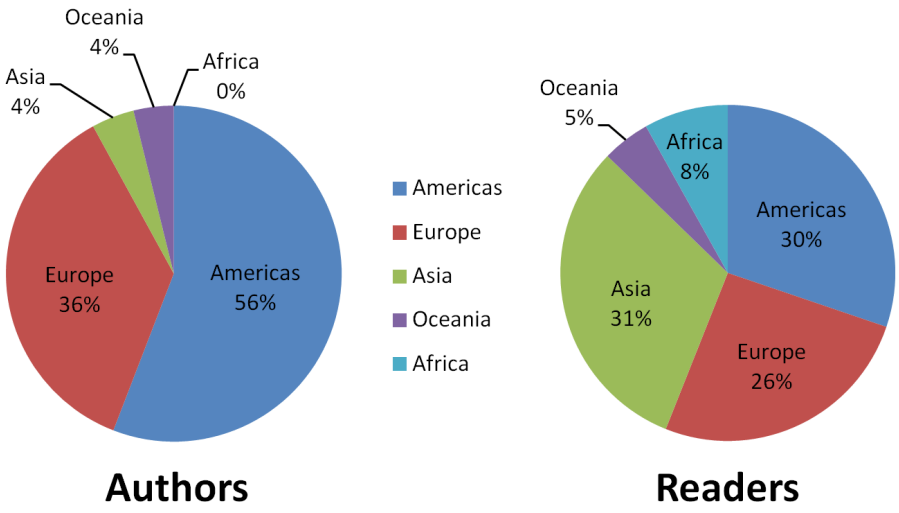

Figure 9. Global distribution of TIM Review authors (2007–2017) and readers (2011–2017

The authors also represent a diversity of roles. Based on their primary affiliations, we identify 56% of authors as representing academia, with 38% of those at the professor or post-doctoral level and 18% being graduate students. Private sector contributors represent 27% of authors and the public and third sectors make up the final 17%. Relative to the OSBR, the TIM Review attracts more academic contributions (McPhee, 2015); however, we note these results under-represent contributors from the private and public sector who are concurrently undertaking graduate studies, which is a common situation in the TIM Program, for example.

Partners

The growth of the TIM Review has been accelerated by partnerships with like-minded and complementary organizations. As the following examples illustrate, these collaborations have typically centered around network building and the production of special issues:

- *Lead To Win:* In several ways, the TIM Review has greatly benefitted from its relationship to the Lead To Win entrepreneurship program (LTW; leadtowin.ca). Led by Carleton University, Lead To Win was recognized by UBI Global as a Top University Business Incubator, which ranked the program seventh overall in North America (Sprott, 2015). In addition to issue sponsorship, the journal has received many contributions from Lead To Win entrepreneurs and mentors, and it has been an ongoing source of insights, ideas, and research projects.

- *ISPIM:* Since March 2013, the TIM Review has published 11 special issues related to conferences and other events held by the International Society for Professional Innovation Management (ISPIM; ispim-innovation.org). Even some of the collaborations underpinning the co-authorship of this article result from relationships built at ISPIM events (e.g., Santonen & Conn, 2015).

- *ENoLL:* The TIM Review's extensive publications on the theme of "Living Labs" (as described earlier) have benefitted from special issues in partnership with the European Network of Living Labs (ENoLL; openliving labs.eu), and the journal has received numerous additional contributions from members of its network.

- *GCR:* The Global Cybersecurity Resource (GCR) is a Carleton University project funded by FedDev Ontario (feddevontario.gc.ca) and focused on growing cybersecurity and cybersecurity-differentiated companies. The GCR has identified analytics – as exemplified by the topic modelling analyses presented earlier in this article – as one means of providing novel and potentially instrumental insights to such companies.

Readership and Citations

Readership growth

Over its 10-year history, the journal has attracted over 1 million readers, defined as unique visitors (or users) according to its website analytics. Early in the journal's

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history, readership fluctuated with the popularity of the current issue. Website analytics data for the OSBR is available from May 2008, and it shows peak readership of 4,400 readers visiting the website in June 2009, which coincided with the publication of the popular special issue on Women in Open Source. However, readership steadily declined over the next year before levelling out at around 1,000 readers per month.

This sustained low level of readership prompted the TIM Program to re-think the journal's objective. A research project was then undertaken to develop a results-based organization design methodology, which drew upon lessons learned from theory and from operating the OSBR, to establish design principles for the re-launch of the journal in October 2011 (McPhee, 2012a, 2012b).

Following the successful re-launch of the journal, and buoyed by its early success in restoring readership to near-peak levels, in May 2012, the TIM Program declared a goal of reaching 10,000 monthly readers of the TIM Review as part of a TIM Lecture that was subsequently published in the journal (TIM Lecture Series, 2012). This goal of tripling the journal's readership was surpassed a little more than a year later. Now, in 2017, current readership levels fluctuate around 25,000 readers per month (Figure 10). In recent years, as the journal's archive has attracted an increasing share of visits, the monthly readership patterns reflect seasonal fluctuations on a background of growth (Figure 10).

Global reach

In the first issue of the OSBR, the founding Editor-in-Chief declared that: "Initially, the scope of the OSBR will be the province of Ontario, then Canada, and eventually the world" (Lavigne, 2007). Although geographical readership data from the OSBR are not available, the authorship data indeed shows a focus centred on the city of Ottawa, where the journal is based at Carleton University, and a strong majority of authors from Canada. As shown above, the author diversity has become increasingly global since the journal was launched, and the readership data shows an even stronger global reach since the re-launch of the journal in 2011. At 31%, Asia has the highest share of readers based on visits to the journal's website (http://timreview.ca) since October 2011 (Figure 9). Close behind, the Americas represent 30% of readers, 19% of which are in the United States. Only 9% of TIM Review readers are based in Canada. The third major component of readership comes from Europe at 26%. Finally, 8% of readers are in Africa 5% are in Oceania.

Popularity

In terms of which publication types have proven most popular with readers, articles (N=590) clearly have the strongest impact given that they have generated 85% of pageviews on the journal's website since the re-launch. On average, an article will generate 2,063 pageviews. Editorials (N=118) generate less than 2% of all pageviews, which suggests that they are only valued by those who

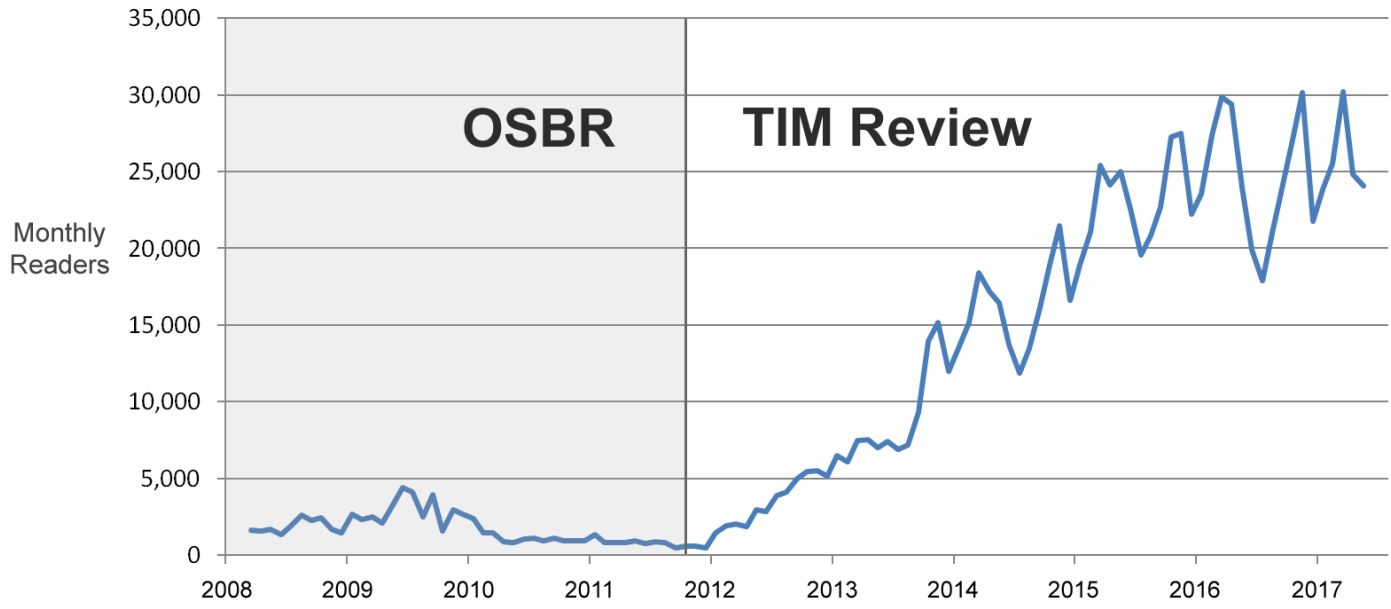

Figure 10. TIM Review readership growth: monthly readers (unique visitors or users) at osbr.ca (May 2008 to September 2011) and timreview.ca (October 2011 to May 31st, 2017)

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read a full issue as a collected work. However, the website analytics show that the vast majority of readers come to the site from a search and read only one article, which means they may not encounter the editorials. The TIM Lecture summaries (N=48) follow a somewhat similar low-impact profile as the editorials: although they capture key messages from the lectures, it is expected that they represent higher value to those who physically attended the lectures compared to those reading their summaries. Finally, for the Q&As (N=39), on the surface, their average of 4,236 pageviews suggests that this publication type has twice the impact of articles. However, a large standard deviation of 18,282 indicates that there is high impact variation for Q&As, and indeed, one Q&A is driving this variation. The Q&A titled "What is customer value and how do you deliver it?" was written by Aparna Shanker (2012) a customer applications engineer with Alcatel-Lucent at the time she was a graduate student in the TIM Program at Carleton University, and it is clearly the most viewed publication in the TIM Review archive. It has generated 114,673 pageviews, whereas the second most popular publication – "Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects", an article by TIM Program Director Tony Bailetti (2012) from the same issue – has generated 67,957 pageviews. Close behind in third position, with 66,721 pageviews, is the article "Social Entrepreneurship: Definition and Boundaries", which was written by Samer Abu-Saifan (2012) while he was a TIM student. These three articles were published in the same February 2012 issue, which was the first in a series of four consecutive issues on Technology Entrepreneurship. As Table 4 shows, most of the publications attracting a high number of pageviews are TIM Review articles; among the 10 most-viewed articles, only two are OSBR articles (ranked 7th and 9th).

Table 4. Top 10 articles by pageviews

Rank	Pageviews	Author and Year	Article Title and Link
1	114,673	Shanker (2012)	Q&A. What Is Customer Value and How Do You Deliver It? timreview.ca/article/525
2	67,957	Bailetti (2012)	Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects timreview.ca/article/520
3	66,721	Abu-Saifan (2012)	Social Entrepreneurship: Definition and Boundaries timreview.ca/article/523
4	49,043	Tanev (2012)	Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector timreview.ca/article/532
5	36,635	Shanker (2012)	A Customer Value Creation Framework for Businesses That Generate Revenue with Open Source Software timreview.ca/article/534
6	30,799	Hakanen & Soudunsaari (2012)	Building Trust in High-Performing Teams timreview.ca/article/567
7	28,233	Savolainen & Häkkinen (2011)	Trusted to Lead: Trustworthiness and its Impact on Leadership timreview.ca/article/429
8	26,891	Abhyankar (2014)	The Government of India's Role in Promoting Innovation through Policy Initiatives for Entrepreneurship Development timreview.ca/article/818
9	18,993	Crenna (2011)	Learning from Failure: A Case Study in Entrepreneurship timreview.ca/article/447
10	18,978	Davies & Gilbert (2011)	A Sales Execution Strategy Guide for Technology Startups timreview.ca/article/491

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Citations

In academic journals, citations are a more traditional way to evaluate publication impact than website pageviews. Therefore, we used Publish or Perish software (harzing.com/pop.htm) to collect all the citations for TIM Review publications, including OSBR publications. Publish or Perish uses Google Scholar citation data, which typically reports a greater number of citations for an article than commercial citation services such as Web of Science and Scopus.

In all, TIM Review and OSBR publications have generated 2,893 citations. A majority of the citations (2,411 citations, 83%) have been generated by TIM Review publications, whereas OSBR publications have generated only 482 citations (17%). Nearly all the citations (N=2827, 98%) have been made to articles, and only a small number of these have had the greatest impact. The top five articles alone account for 21% of all citations, and the top 10 account for 32% of all citations. In all, there are only three publications with more than 100 citations. Furthermore, for articles, pageviews as a genuine impact metric was also partially validated: article pageviews and citations were moderately correlated (0.536**, sig. 0.000). As Table 5 shows, most of the publications attracting a high number of citations are TIM Review articles; among the 10 most-cited articles, only one is an OSBR article (ranked 4th). Notably, articles on living labs represent 4 of the top 10 articles (and 12 of the top 20 articles; not shown).

Table 5. Top 10 most-cited articles

Rank	Citations	Pageviews	Author and Year	Article Title and Link
1	179	66,721	Abu-Saifan (2012)	Social Entrepreneurship: Definition and Boundaries timreview.ca/article/523
2	133	4,162	Westerlund et al. (2012)	Living Labs as Open-Innovation Networks timreview.ca/article/602
3	105	4,363	Almirall et al. (2012)	Mapping Living Labs in the Landscape of Innovation Methodologies timreview.ca/article/603
4	93	8,518	Sanders & Simons (2009)	A Social Vision for Value Co-creation in Design timreview.ca/article/310
5	92	5,190	Westerlund & Leminen (2011)	Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs timreview.ca/article/489
6	85	67,957	Bailetti (2012)	Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects timreview.ca/article/520
7	65	8,946	Westerlund (2014)	Designing Business Models for the Internet of Things timreview.ca/article/807
8	47	6,066	Moogk (2012)	Minimum Viable Product and the Importance of Experimentation in Technology Startups timreview.ca/article/535
9	46	1,799	Juujärvi & Pesso (2013)	Actor Roles in an Urban Living Lab: What Can We Learn from Suurpelto, Finland? timreview.ca/article/742
10	45	49,043	Tanev (2012)	Global from the Start: The Characteristics of Born-Global Firms in the Technology Sector timreview.ca/article/532

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The author citation profile is very similar to the publication citation profile. In all, 258 authors (34%) out of 751 who have published an article have not received any citations, and 112 authors (15%) have received only one citation. The top 10 authors in terms of article citations are listed in Table 6. Being an active author strongly explains the number of citations: the number of article publications is moderately correlated with citations (0.638**, sig. 0.000).

Conclusion

This journal was launched 10 years ago by the Talent First Network and the TIM Program at Carleton University to promote economic development by providing companies within its region with competitive advantages through increased understanding of the business side of open source. However, not only did this primary goal change over time in parallel with the evolution of the TIM Program, the journal was also intended to provide additional benefits, which took on increasing importance over time as the scope of the journal and its global reach expanded.

In terms of the next 10 years, the journal seeks to continue to provide benefits to its readers, contributors, partners, and other stakeholders, particularly through increased growth and the use of innovative technologies. For example, the journal is developing new tools based on machine learning and topic modelling to deliver increased value to its various audiences. Future growth will depend on further community building and partnerships to reach new contributors and readers. We will apply the lessons of the journal's past when considering its future.

Table 6. Top 10 most-cited authors and their number of articles

Rank	Citations	Author	Articles	Country	Primary Affiliation
1	416	Seppo Leminen	11	Finland	Laurea University of Applied Sciences
2	390	Mika Westerlund	15	Canada	Carleton University
3	179	Samer Abu-Saifan	1	Canada	Carleton University
4	172	Tony Bailetti	19	Canada	Carleton University
5	138	Stoyan Tanev	13	Denmark	University of Southern Denmark
6	133	Anna-Greta Nyström	2	Finland	Åbo Akademi University
7	120	Dimitri Schuurman	10	Belgium	imec
8	105	Esteve Almirall	1	Spain	ESADE Business School
	105	Jonathan Wareham	1	Spain	ESADE Business School
	105	Melissa Lee	1	Spain	ESADE Business School
9	93	George Simons	1	United States	NBBJ
	93	Liz Sanders	1	United States	MakeTools
10	77	Steven Muegge	10	Canada	Carleton University

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Acknowledgements

The 10-year history of the TIM Review and all its successes are the result of countless small and large contributions from its readers, authors, reviewers, board members, partners, funders, sponsors, and champions, particularly the Director of the TIM Program, Tony Bailetti, as well as the staff and faculty of the TIM Program at Carleton University and the journal's founding Editor-in-Chief, Dru Lavigne.

The authors also gratefully acknowledge funding from FedDev Ontario through the Bayview Yards business acceleration shop in Ottawa, Canada, which enabled the topic modelling analyses presented in this article and the related tools being developed to further enhance the value of the journal to its readers and contributors.

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Citation: McPhee, C., Santonen, T., Shah, A., & Nazari, A. 2017. Reflecting on 10 Years of the TIM Review. *Technology Innovation Management Review,* 7(7): 5–20. http://timreview.ca/article/1087

Keywords: TIM Review, OSBR, journal, open source, technology, innovation, management, entrepreneurship, business, research, topic, topic modelling, scientometric analyses

The Defining Characteristics of Urban Living Labs

Kris Steen and Ellen van Bueren

> *"Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody."*
>
> Jane Jacobs (1916–2006)
> Journalist, author, and activist
> In *The Death and Life of Great American Cities*

The organization of supported and sustainable urban interventions is challenging, with multiple actors involved, fragmented decision-making powers, and multiple values at stake. Globally, urban living labs have become a fashionable phenomenon to tackle this challenge, fostering the development and implementation of innovation, experimentation, and knowledge in urban, real-life settings while emphasizing the important role of participation and co-creation. However, although urban living labs could in this way help cities to speed up the sustainable transition, urban living lab experts agree that, in order to truly succeed in these ambitious tasks, the way urban living labs are being shaped and steered needs further research. Yet, they also confirm the existing variation and opaqueness in the definition of the concept. This article contributes to conceptual clarity by developing an operationalized definition of urban living labs, which has been used to assess 90 sustainable urban innovation projects in the city of Amsterdam. The assessment shows that the majority of the projects that are labelled as living labs do not include one or more of the defining elements of a living lab. In particular, the defining co-creation and development activities were found to be absent in many of the projects. This article makes it possible to categorize alleged living lab projects and distill the "true" living labs from the many improperly labelled or unlabelled living labs, allowing more specific analyses and, ultimately, better targeted methodological recommendations for urban living labs.

Introduction

By 1969, before the term "sustainable development" was commonly known, the United States Congress had already emphasized the need to "create and maintain conditions that permit fulfilling the social, economic and other requirements of present and future generations" (U.S. Congress, 1969). It is apparent that the current systems of urban life and development do not succeed in achieving this sense of sustainability in cities, thereby demonstrating the need for urban innovation to contribute to the sustainability transition of cities (Joss, 2015; Wheeler & Beatley, 2015).

However, many sustainable urban innovations at present do not systemically find their way to the market, inhibiting their wider implementation and limiting their positive impact potential in the context of this urban sustainability transition (Ashuri & Durmus-Pedini, 2010; van Bueren & Broekhans, 2013). The living lab approach is believed to close this gap between production and actual market uptake by directly involving all end users and other urban stakeholders into the development of new products. This would ensure a match with the actual needs and aspirations of the users while taking into account the local and institutional contexts, cultures, and creativity potentials (ENoLL, 2006; Kresin, 2009; Lemke, 2009; Lesnikowski et al., 2016; van Bueren & De Jong, 2007). Furthermore, the new partnerships and the inclusion of new, multidisciplinary stakeholders in the development process is believed to provide new insights and offer new, more integrated solutions to the investigated problems, thereby advancing the generation of innovations (ENoLL, 2006; Vincent, 2016).

The Defining Characteristics of Urban Living Labs

Kris Steen and Ellen van Bueren

Given these alleged benefits, it is no surprise that, in recent years, the "urban living lab" has become a popular development approach on which hope is fixed to accelerate the generation and adoption of sustainable innovations in the urban system in the light of the urban sustainability transition. However, evaluative accounts of urban living labs in practice indicate that many of these experience difficulty in achieving the full benefits of this approach (Bulkeley & Castán Broto, 2013; Franz et al., 2015; Karré et al., 2015; Schuurman et al., 2016). These authors point to a lack of methodological deepening of the living lab approach as a reason for such difficulties. Yet, in order to provide targeted methodological recommendations, it is necessary to take a closer and more precise look at the aim of urban living labs. Analysis of the (urban) living lab literature and the variety of existing urban living labs, for example those presented at the ENoLL website (openlivinglabs.eu), shows that there is no consensus on this issue. The way an urban living lab is defined and used is diffuse, with many different and often abstract definitions of the concept, leaving participants involved in urban living labs in the dark as to how the "living lab dimension" makes this project different from other urban innovation projects.

This article focuses on establishing a definition of urban living labs, which will show what can be expected from urban living labs and which will provide guidance to actors engaged in urban living labs or contemplating starting one. The definition presented in this article has been based on the existing living lab literature. Additionally, a scan of 90 Amsterdam-based sustainable urban innovation projects has provided insights on the representation of "true" urban living labs, fostering co-creative innovation among the more traditional sustainable urban innovation initiatives. We conclude by identifying some key challenges to the implementation of urban living labs.

Defining "Urban Living Lab"

The term "urban living lab" is to refer to a variety of local experimental projects of a participatory nature. It is often used interchangeably with the terms "testing ground", "hatchery", "incubator", "making space", "testbed", "hub", "city laboratory", "urban lab", or "field lab". Although there are many publications on living labs and urban living labs, even in these texts, this notion of the urban living lab has not been defined clearly. In literature discussing the "theory" of (urban) living labs, they have been explain ed as a methodology (Eriksson et al., 2005), as an environment (Ballon et al., 2005; Schaffers et al., 2007), as a system (CoreLabs, 2007), and as a governance approach (Bulkeley et al., 2016).

To explore the variety of definitions and understandings of the concept, we have analyzed articles on (urban) living labs published in this journal, the *Technology Innovation Management Review* (TIM Review) and other journals. The articles in the TIM Review are particularly relevant because this journal has played a considerable role in the transformative debate on the essence, role, and shape of urban living labs, with, in addition to separate articles on this topic, special issues attributed to this topic in 2012, 2013, 2015, 2016, and 2017. Appendix A presents an overview of the definitions used in these issues.

Almost all the articles we found on (urban) living labs, including those published in other journals, referred to the variation and opaqueness in the definition of the concept. Often, these articles, which are presented in Appendix B, adopt existing definitions, such as the one used by the European Network of Living Labs (ENoLL): "Living labs are defined as user-centered, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings" (ENoLL, 2016). These definitions aim to grasp the essence of living labs in one sentence, mentioning the main aspects and the relations between these aspects, often using complex concepts. Besides these single-sentence definitions, there are authors who provide a rich description of the phenomenon, but do not define it. Other authors distinguish different "types" of living labs (e.g., Leminen, 2013) or imply that living labs are environments offering a "multitude of different projects" (Tuija Hirvikoski, President of ENoLL, in an open discussion on February 13, 2017). Finally, there are authors that simply refer to an empirical example (e.g., Femenías & Hagbert, 2013) or skip the usual explanatory paragraph altogether and discuss "living labs" as an already accepted notion (e.g., Coorevits & Jacobs, 2017). We see only a few examples where authors operationalize this definition by formulating key principles, defining elements, or building blocks of living labs (Schuurman et al., 2013; Ståhlbröst, 2012; Veeckman et al., 2013). Yet, gradually, in the current living lab literature, a stabilized conception of living labs with roughly similar characteristics has emerged.

Characteristics

As described in the subsections below, we have drawn on the living labs articles published in the TIM Review and in other journals and documents to capture the de-

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fining characteristics of urban living labs. In total, we identified nine characteristics in four dimensions: i) aim ii) activities, iii) participants, and iv) context. For each dimension, the defining characteristics of urban living labs are described in the subsections that follow, and the complete list of defining characteristics of urban living labs, presenting the full urban living lab definition, is summarized in Table 1.

Aim

The overall aim of living labs is to learn and experiment, by integrating processes of research and innovation (ASC, 2016; Bijsterveldt, 2016; ENoLL, 2016). The innovation aspect refers to the development of new products (i.e., an object, service, technology, application, process, or system) and to the discovery of new solutions to existing problems. Learning and experimenting (McCormick, 2016; Pallot & Pawar, 2012; Schaub, 2016; Vincent, 2016) refers to the production and exchange of knowledge among participants (ASC, 2016; Bijsterveldt, 2016; Friedrich et al., 2013; Heijden, 2016; McCormick, 2016; Pallot & Pawar, 2012). Thus, the aim is not only to learn from the experiences from the particular lab environment, but also to replicate the innovation elsewhere, in real life, or to further future innovation (ASC, 2016; Bijsterveldt, 2016; Franz et al., 2015; Juujärvi & Lund, 2016). It is this emphasis on formalized knowledge production – lessons that are formulated and that can be disseminated – that sets living labs apart from other policy experiments and niches of innovation (Evans & Karvonen, 2014).

"Urban" living labs distinguish themselves from living labs by unanimously displaying an explicit territorial focus on finding local sustainable solutions addressing wicked problems that tend to be global, such as climate change and energy transition. The use of cities or parts of cities as laboratories is well in line with the current emphasis on the city as the impactful governance level for economic development (e.g., Glaeser, 2011; Barber, 2013; Katz & Wagner, 2014) and for sustainable development (e.g., van Bueren et al., 2012; Bulkeley & Betsill, 2013). It also responds to calls for citizen empowerment (e.g., Saurugger, 2010; Fung, 2015).

Table 1. Overview of the defining characteristics of living labs

Aspects	Characteristics
Aims	Aimed at **innovation**
	Aimed at **formal learning** for replication
	For urban living labs: Aimed at increasing **urban sustainability**
Activities	**Development** (all phases of the product development process)
	Co-creation
	Iteration (feedback, evaluation, and improvement)
Participants	**Public actors**, **private actors, users** and **knowledge institutes** participate in the living lab activities
	All actors involved have **decision-making power**
Context	The living lab activities take place in the **real-life use context** of the innovation. In many urban living labs, this is a territory or a space-bound place.

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Activities

There are a number of activities that are supposed to take place in living labs. Living labs should comprise the *development* of a product, which can be all sorts of artifacts, including process innovations, and not only, for example, testing or implementation (Budweg et al., 2011; Coenen et al., 2014; Feurstein et al., 2008; Gray et al., 2014; Leminen, 2015; Schaffers et al., 2007; Tang & Hämäläinen, 2012). A key element in this development process is *co-creation* (Bijsterveldt, 2016; ENoLL, 2016; Feurstein et al., 2008; Franz et al., 2015; Gómez-Barroso et al., 2009; Heijden, 2016; Schaub, 2016). The essence of a living lab is that the solution is sought together *with* the user, rather than just applying a fixed solution and involving the user only for testing. To qualify as co-creation, the targeted users need to be involved in the various development phases of the living lab process: not only should they be asked for their opinions, they should have decision-making power throughout the phases (Prahalad & Ramaswamy, 2004). Furthermore, the development process of living labs is iterative, which implies that, after being designed, the (prototype) product is used and evaluated by the stakeholders. The feedback and evaluation gathered from these steps are used to further develop and improve the product (Feurstein et al., 2008; Pallot & Pawar, 2012; Pierson & Lievens, 2005).

Participants

The literature further shows that the living lab is a systematic innovation approach in which all stakeholders – all actors who have a stake in the developed product and the process leading to it – participate directly in the development process. Stakeholder participation, including users, is an integral part of the development process in living labs (Feurstein et al., 2008).

The actors who need to participate in the living lab activities are, at a minimum: users (the end users of the final product that will be developed; in many cases, citizens), private actors (businesses, firms, companies), public actors (governments and public institutions), and knowledge institutes. The participation of knowledge institutes emphasizes the aim of formalized knowledge production (Krueger & Buckingham, 2009; Perry, 2006). As mentioned, these actors not only need to participate in these activities but also need to have power to influence the process (Prahalad & Ramaswamy, 2004). This power allows these actors, including the end users of the product, to be active partners in the innovation and development during the whole process, rather than just passive consumers and receivers and subjects of R&D activities (Almirall et al., 2012; Feurstein et al., 2008; Friedrich et al., 2013; Higgins & Klein, 2011; Leminen, 2015; Schaub, 2016).

Context

Authors on living labs unanimously agree that a defining characteristic of living labs is that they take place in real-life environments. The complexity and multi-contextuality that is connected to real-life environments is part of the challenge of living labs (Feurstein et al., 2008; Friedrich et al., 2013). Whether these real-life environments are limited to physical environments (Feurstein et al., 2008; Friedrich et al., 2013; Kieboom, 2013; Leminen, 2015; McCormick, 2016; Westerlund & Leminen, 2011) or also comprise virtual realities (Feurstein et al., 2008; Leminen, 2015) is contested. In this research, the criterion used is that the product central to the living lab is being developed and evaluated in its real-life *use context*. Given that this product can also be a virtual product, such as a digital data-gathering system, virtual realities can also form the context of living labs. More often, however, the living labs will take place in a physical place, such as a neighbourhood, city, or other area. The wide attention for *urban* living labs emphasizes the need or desire of involved stakeholders to capture the real-life context in all its complexity while assuming that such experiments, despite the highly uncontrolled conditions, nevertheless produce useful, transformative knowledge (Evans & Karvonen, 2013).

An overview of the defining living lab characteristics mentioned in the living lab definitions presented in the literature is provided in Figure 1. This figure shows a high level of agreement among the authors of the texts studied on the characteristics of living labs, leading to the synthesised definition presented in Table 1. In addition, Appendix B lists how authors have worded these living lab characteristics, which shows the original variety of concepts to which authors referred to convey these characteristics and demonstrating the need for operationalization of these concepts to be of guidance to stakeholders involved in urban living labs.

Living labs vs. urban living labs

The characteristics of living labs and *urban* living labs are very similar, and we assume that the general characteristics of living labs and recommendations for their design and operation are generally applicable to urban living labs as well. The difference between living labs and urban living labs is the explicit focus on finding solutions meant to increase urban sustainability. The inclusion of this explicit aim of increasing urban sustainability in the problem and goal statement of a living

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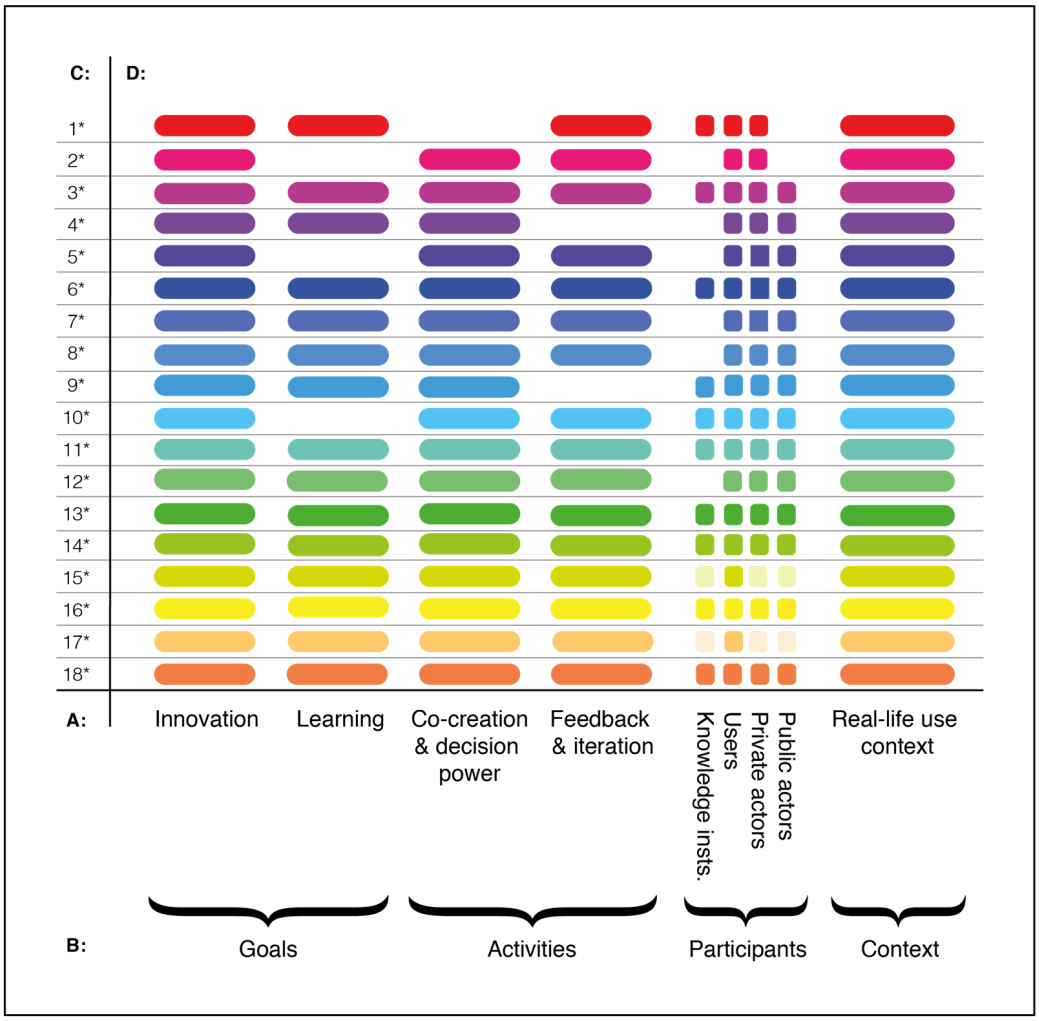

A = Proposed defining characteristics of living labs

B = Dimensions applicable to the defining characteristics

C = The definitions of 'living lab' provided in literature

D = Presence of the proposed defining characteristics in the living lab definitions provided in literature

1*: William Mitchell (MIT), ca. 2003
2*: Niitamo, Kulkki, Eriksson & Hribernik, 2006
3*: Ballon, Pierson, & Delaere, 2005
4*: European Network of Living Labs, 2006
5*: Kusiak, 2007
6*: Schaffers, Cordoba, Hongisto, Kallai, Merz & Van Rensburg, 2007
7*: Almirall & Wareham, 2008
8*: Feurstein, Hesmer, Hribernik, Thoben & Schumacher, 2008
9*: Bergvall-Kåreborn & Ståhlbröst, 2009
10*: Westerlund & Leminen, 2011
11*: Higgins & Klein, 2011
12*: Pallot and Pawar, 2012
13*: Friedrich, Karlsson & Federley, 2013
14*: Leminen, 2015
15*: Franz, Tausz & Thiel, 2015C
16*: Voytenko, McCormick, Evans, & Schliwa, 2016
17*: Hakkarainen & Hyysalo, 2016
18*: GUST, 2016

Figure 1. Overview of the presence of the proposed defining living lab characteristics in the autonomous living lab definitions provided in literature, focusing only on definitions introducing self-worded determinations of an (urban) living lab (not or besides quoting previously proposed definitions)

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lab is a concrete feature of urban living labs – a feature that is often vaguely referred to by urban living lab authors as the "urban" dimension. This view is also consistent with the intuitive conception of scholars and practitioners that there *is* a difference between "normal" living labs and "urban" living labs in terms of increased complexity. The intricate number of variables and relationships influencing the process and outcome of urban living labs compared to "normal" living labs is exactly the learning environment that urban stakeholders tend to look for and appreciate. It helps them to develop real-world solutions to real-world problems while emphasizing the need for these solutions to work.

The use of living labs in cities may also raise questions about the inclusiveness and democratic accountability of the selection of areas for living labs, and about the focus of the innovation. Indeed, many innovations tend to be technological and are driven by ICT and decentralized technologies with ambitions to become "smart" and "low carbon". These are highly relevant questions, but they are beyond the focus of this article, which focuses on the living lab phenomenon itself.

Living Labs in Practice

Despite the popularity of urban living labs, stakeholders being engaged in living labs or wanting to start a living lab are struggling with what it actually is that they are supposed to do in an urban living lab. To answer this question, we have identified and quickly scanned the urban living labs in the Amsterdam metropolitan region. Given that urban living labs are not necessarily labelled as such, the identification of urban living labs in Amsterdam was not based on the projects calling themselves a living lab or an urban living lab, but on projects *potentially* being classified as an urban living lab based on their characteristics. This approach led to a sample of 90 sustainable urban innovation projects (for details, see Steen & van Bueren, 2017) with attention for the citizens or end users in their project descriptions. The projects were identified through snowball sampling using a mixture of sources: policy documents; research papers; the Internet; and suggestions from experts working at the municipality of Amsterdam, Amsterdam SmartCity (a public organization aimed to collect and disseminate knowledge on smart city initiatives in the Amsterdam region), AMS (the Amsterdam Institute for Advanced Metropolitan Solutions), and other Amsterdam-oriented researchers. Based on the project descriptions found in online and offline sources, one researcher verified which of the defining living lab characteristics (Table 1) were present in each of the 90 projects.

During this search, some notable observations were made. Of the nine characteristics of urban living labs, the characteristics of *development* taking place in the lab and of *co-creation* applying to the living lab activities were found to be the two urban living lab characteristics most frequently absent in sustainable urban innovation projects in Amsterdam. Of the 90 scanned projects, only 12 displayed these two characteristics. Of these 12 projects, all of them contained the remaining seven urban living lab characteristics (Table 1), thus qualifying as urban living labs. Surprisingly, most of these projects are not the ones calling themselves "living labs" or "labs". In fact, only three of the 14 projects with "living lab" in their name and two of the 14 projects with "lab" in their name met the identified defining characteristics of an urban living lab. The other seven projects from the 90 urban innovation projects in Amsterdam that were identified as urban living labs did not use any reference to "lab" of "living lab" in their name.

In this article, we hone in on the challenges experienced with these two urban living lab characteristics of "developing an innovation" and "co-creation", which have been identified as the two urban living lab characteristics most frequently absent in sustainable urban innovation projects.

Innovation challenges

The analysis of 90 sustainable urban innovation projects in Amsterdam shows that, besides development of an innovation, which is a criterion for urban living labs, a number of other innovation-related activities can be central in the projects.

From the literature on the innovation process – whether it concerns new product development (Cooper, 1988), agile development (Beck et al., 2001), or user-driven (open) innovation processes (Von Hippel, 2005; Mikkela, 2008) – we have identified five overarching phases in the innovation process and used them to categorize the projects:

1. *Research:* "An investigative process of revising current knowledge employed to reach understanding of a subject for the purpose of making decisions" (Cambridge Dictionary: dictionary.cambridge.org).

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2. *Development:* "The process of the product being created, growing, and changing in order to become more advanced" (Business Dictionary: businessdictionary.com).

3. *Testing:* "Application of a product for the purpose of observing and assessing its functionality" (Merriam-Webster: merriam-webster.com).

4. *Implementation:* Implementation of a finished product in a real-life environment.

5. *Commercialization of the developed product:* Demonstrating a previously developed and implemented product.

The first four phases largely coincide with the natural stages of product maturation in the product development process (Cooper, 1998). The fifth phase is emphasized in the literature on user-driven, open innovation, and new product development, where the convincing of users who have not been involved in the development process needs more attention. It should be noted that this phasing is presented as a linear process. In reality, the sequence of these phases is not fixed, and processes take place in iteration.

Ideally, an innovation project would cover all these phases. In practice, we observed that each of the projects focussed on a particular phase of the innovation process (according to the pattern visualised in Figure 2). The projects aimed specifically at researching, developing, testing, implementing, or commercializing a solution. According to the living lab characteristics, only the projects (also) conducting *development* activities qualify as urban living labs.

User involvement challenges

Even though innovation in urban living labs theoretically should take place in co-creative processes in which participants can participate and influence decisions in all phases of the innovation process, this was rarely seen in the 90 investigated sustainable urban innovation projects in Amsterdam. When looking at the literature, we consider Sherry Arnstein's "ladder of citizen participation" (1969) the most usable elementary scale for measuring the degree of user involvement in the projects studied, with the three main levels of involvement being decision-making power, tokenism, and non-participation. As in the literature on co-creation (Prahalad & Ramaswamy, 2004), Arnstein associates true participation with the possession of (decision-making) power. The second level of participation identified by Arnstein is tokenism: the action of symbolically allowing people to "participate" without actually providing them with power in the decision-making process. The third main level distinguished is non-participation.

When projecting Arnstein's model onto the 90 potential living lab projects, we simply considered the first level as "participation" and the other two levels (tokenism

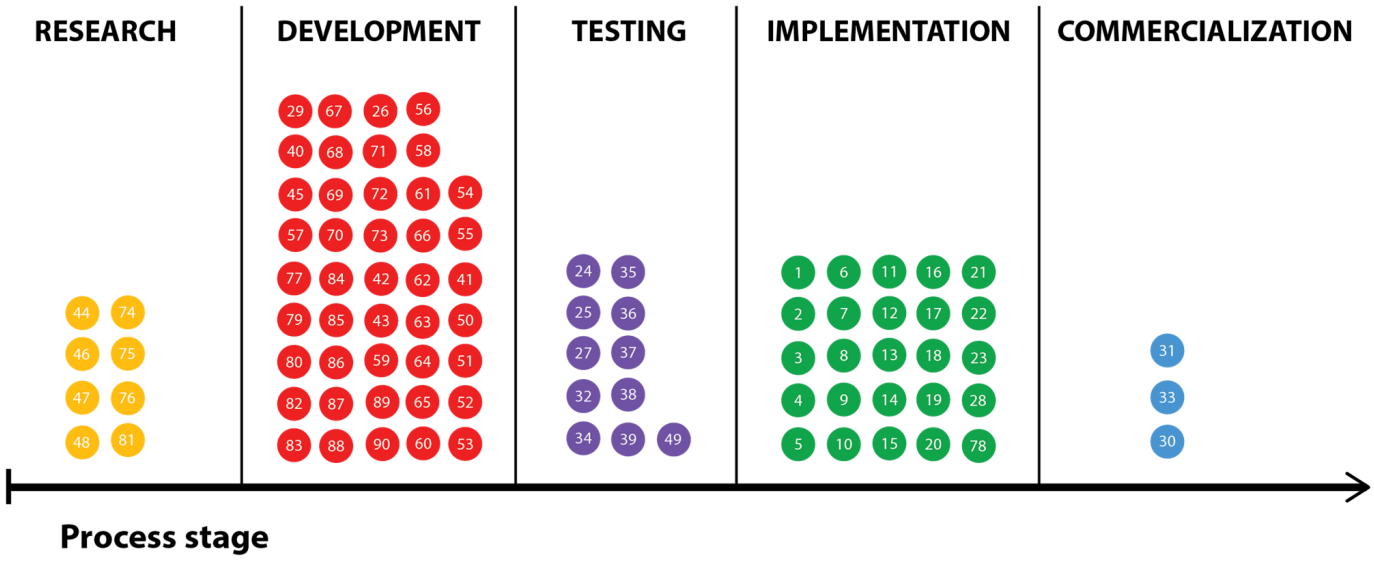

Figure 2. Classification of innovation process phase of 90 potential living lab projects in the Amsterdam region

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and non-participation) as "no participation", because decision-making power by stakeholders, including users, has been shown to be conditional for living labs. Following this criterion, user participation only occurred in 51 of the 90 urban innovation projects, and, although this may sound as if co-creation takes place, user participation in the project activities is in fact quite common, if not inherent, when the project activities concerned are testing, implementation, and demonstration. However, *development* with the user (i.e., with the user participating and having decision-making power in the *development* process of the developed product) is the only form of user involvement that actually enables co-creation, which is one of the characteristics of living labs. The scan of the 90 sustainable urban innovation projects in Amsterdam found development with the user in only 12 of the projects.

When looking more closely at the sustainable urban innovation projects in Amsterdam associated with a living lab approach *not* including user participation, these projects do display a significant focus on user-related activities (Figure 3). Two-thirds of these projects either clearly adopt a user perspective and specifically aim to deliver solutions for the *end user* rather than for public or industry partners, or they perform their project activities with the help of digital user data that the user actively or passively provides, for example through iBeacons, smartphone applications, or smart meters. The first form of this user focus – in which the user does not directly participate (i.e., there is no co-creation) but the user is included in other ways – can be referred to as "user oriented", following the definition of "user-oriented design" by Veryzer and de Mozota (2005). The second form can be referred to as "user sourced", which indicates that project activities are performed using virtual user data, which is actively or passively provided by the user.

Conclusions

Although urban living labs are widely implemented in urban contexts and are popular projects to allegedly catalyze sustainable urban innovation and the sustainable transition, their definition remains unclear, both in real life as well as in the literature. This article has set up a demarcating definition of the concept of urban living labs in order to allow researchers to further investigate this topic. After a literature review on the common denominators of living lab projects, a framework has been set up outlining the defining features of living labs in terms of goals, activities, participants, and context, making it possible to categorize and diversify alleged living lab projects and distill the real living labs from the many improperly labelled or unlabelled living labs, allowing more specific analyses and recommendations.

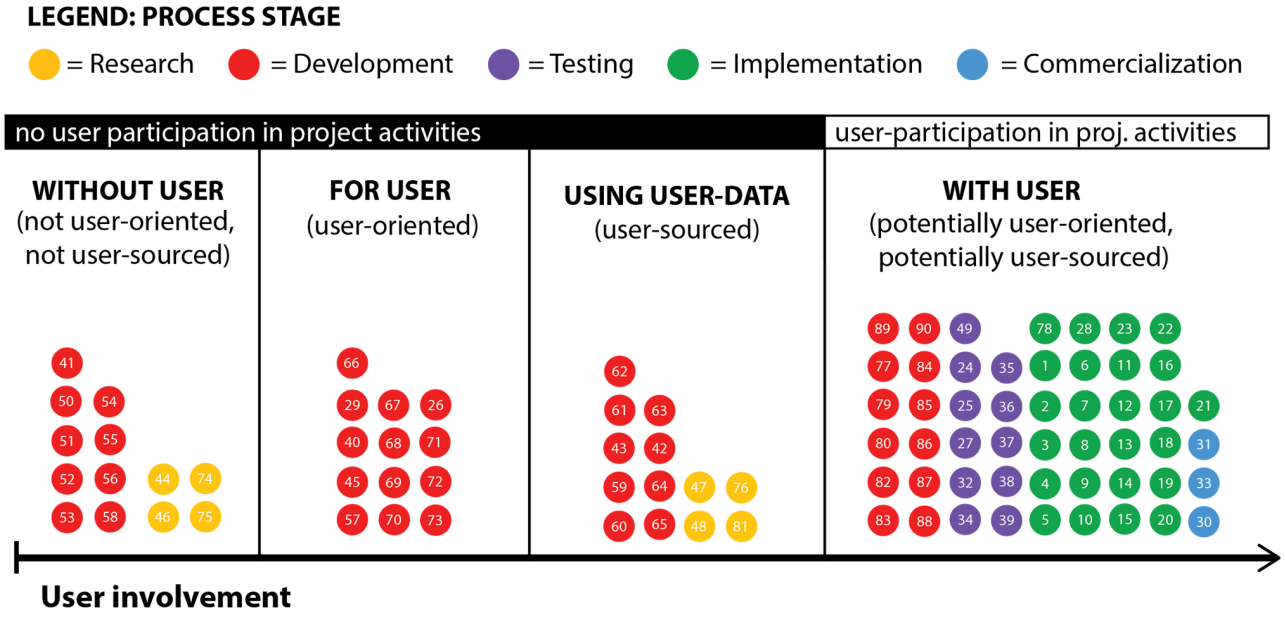

Figure 3. Degree of user involvement in the 90 potential living lab projects in Amsterdam

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Based on a scan of 90 sustainable urban innovation projects and alleged living lab projects in Amsterdam, the majority of the projects that are labelled as living labs in fact do not include one or more of the defining elements of living labs, and sometimes are not even so much different from traditional top-down product development processes. However, given that many of the benefits attributed to living labs are linked to precisely to these defining characteristics, with co-creation and innovation as the most distinguishing ones, the absence of some of these basic components of living labs will also lead to disappointing performance in the field of these alleged benefits.

In order to develop an urban living lab design that does achieve the sustainable outcomes that the texts and definitions on living labs outline, the methodology of urban living labs should be more closely studied. For example, in this context, it would be valuable to extract the details of the methods recommended in the living lab literature and how they compare to the methods being used in practice, what the drivers and barriers are for the emergence and implementation of sustainable urban innovations, and which other methodological lessons can be learned from previous experiences with urban living labs. Reformulating these findings in the form of recommendations regarding the methodology, design, and governance of urban living labs would enhance the ability of urban living labs to achieve successful development, adoption, and replication of sustainable urban innovations. These aspects were beyond the scope of the current study, but could be addressed in future research.

In closing, we emphasize that today's popularity of living labs, also among subsidizing programmes preferring or demanding living labs as a research method, sometimes leads to a choice for a living lab approach without relating it to the project aims. With their specific co-creation requirement, living labs are certainly not applicable to every urban innovation project. Especially with regards to projects developing highly technological innovations, often pursued in the search for smart and sustainable cities, co-creative development, as is expected in living labs, can pose large challenges while not necessarily contributing to the quality of the solution.

Acknowledgements

This article is an outcome of a research project run under the auspices of the Amsterdam Institute for Advanced Metropolitan Solutions (AMS). We would like to thank the partners of the AMS Institute for their contribution to this research.

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Citation: Steen, K., & van Bueren, E. 2017. The Defining Characteristics of Urban Living Labs. *Technology Innovation Management Review*, 7(7): 21–33. http://timreview.ca/article/1088

Keywords: living labs, urban living labs, definition, characteristics, cities, TIM Review

Appendices

Available online at: tinyurl.com/ycoua757

Appendix A. Overview of definitions of living labs in the TIM Review

Appendix B. Defining characteristics of (urban) living labs mentioned in living lab literature

Inclusive Innovation in Developed Countries: The Who, What, Why, and How

R. Sandra Schillo and Ryan M. Robinson

> *"There's something cooking and the lights are low.*
> *Somebody's trying to save our mother earth.*
> *I'm gonna help them to save it,*
> *To sing it and bring it,*
> *Singing: No no Keshagesh [greedy guts]*
> *You can't do that no more, no more, no more, no more..."*
>
> Buffy Sainte-Marie
> Canadian singer-songwriter, visual artist, and social activist
> In "No No Keshagesh"

Although widely appreciated as an important driver of economic growth, innovation has also been established as a contributor to increasing economic and social inequalities. Such negative consequences are particularly obvious in the context of developing countries and extreme poverty, where innovation's contributions to inequalities are considered an issue of social and economic exclusion. In response, the concept of inclusive innovation has been developed to provide frameworks and action guidelines to measure and reduce the inequality-increasing effects of innovation. In developing countries, attention has only recently turned to the role of innovation in increasing inequalities, for example in the context of the degradation of employment in the transition from production to service industries. Although the focus of this early work is primarily on economic growth, innovation in developed countries also contributes to social exclusion, both of groups traditionally subject to social exclusion and new groups marginalized through arising innovations. This article summarizes the origins of the concept of inclusive innovation and proposes a four-dimensional framework for inclusive innovation in developed countries. Specifically, innovation needs to be inclusive in terms of people, activities, outcomes, and governance: i) individuals and groups participating in the innovation process at all levels; ii) the types of innovation activities considered; iii) the consideration of all positive and negative outcomes of innovation (including economic, social, and environmental); and iv) the governance of innovation systems. This framework is intended to guide policy development for inclusive innovation, as well as to encourage academics to investigate all dimensions of inclusive innovation in developed countries.

Introduction

Innovation, traditionally defined as the development of new goods, services, or processes, has long been an important driver of positive outcomes such as economic growth and societal well-being. However, a range of longer-term trends combined with the recent financial crisis and slow recovery have made it obvious that innovation also plays an important role in creating negative outcomes, such as income inequalities (Aghion et al., 2015). In many developing countries, overall economic growth is no longer associated with socio-economic improvements for the poorest (Chataway et al., 2014). In developed countries, inequalities have increased to a level where they are socially and economically damaging (Stiglitz, 2012), giving rise to criticism of scientists and innovators as "remote elitists" (Long & Blok, 2017).

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Notionally, inclusive innovation has the potential to be a socially responsible endeavour (Fisher, 2017) – a means to address social and economic exclusion. This article discusses the concept of inclusive innovation and provides a framework of four key dimensions to consider in its implementation. The discussion of the framework's four dimensions – people, activities, outcomes, and governance – highlights that superficial implementation of inclusiveness concepts is unlikely to lead to the achievement of economic, social and environmental goals. Rather, true inclusiveness with economic, social, and environmental benefits will require a broader definition of innovation; structural and post-structural changes within the innovation landscape; reflexive and evolutionary policy design; and ample societal space for experimentation and exploration of different innovation narratives.

Theoretical Precursors to Inclusive Innovation

There is now broad consensus that innovation does not only serve economic growth and competitiveness, but that governments invest in innovation with a broad range of further objectives(Bozeman & Sarewitz, 2011; Lindner et al., 2016; Mazzucato & Semieniuk, 2017; Miller & Neff, 2013; Schillo & Kinder, 2017). This increased awareness of non-economic objectives is often framed in the context of "grand challenges" (Hicks, 2013; Kallerud et al., 2013) and has been applied extensively in policy development in Europe, the United States, and many other countries.

The arising expectations of innovation are immensely broad. At a high level, policy developers and citizens look to innovation to contribute to the solution of society's "grand challenges" (Kallerud et al., 2013), but there are also specific issues to which innovation is expected to make contributions, such as the introduction of low-carbon technologies (Andersen & Johnson, 2015), agriculture and development (Joseph, 2014), and education. The emphasis on these expectations has increased substantially over the past 15 years (Hicks, 2016; Lindner et al., 2016), and researchers have suggested that it may lead to a new social contract of science and innovation (Owen et al., 2013) and may fundamentally transform both science and policy making (Kuhlmann & Rip, 2014).

This broad societal and policy interest in the potential of innovation to contribute to society has been paralleled by several developments in the academic literature:

Public value mapping (Bozeman & Sarewitz, 2011) is based on the theory of public value failure (Bozeman, 2002). This theory is a response to the prevalence of market failure motivations in public policy in general, and in science and innovation policy in particular. It is based on the assertion that governments should work in the public interest, and that market failure rationales do not provide sufficient motivation to address public values. An extensive body of literature has further developed this theory and approach, which has found broad resonance in the science policy community, and has recently also been brought into the discussion on responsible innovation (von Schomberg, 2014).

The quintuple helix (Carayannis & Campbell, 2010; Carayannis et al., 2012) theory is similar in that it seeks to highlight considerations of societal importance, but it focuses specifically on the contributions of innovation to global warming and related environmental concerns. It builds on quadruple helix theory, which already integrates innovation into its social context, and sees "government, academia, industry, and civil society […] as key actors promoting a democratic approach to innovation through which strategy development and decision-making are exposed to feedback from key stakeholders, resulting in socially accountable policies and practices" (Carayannis & Campbell, 2012). As such, quintuple and n-tuple theory (Leydesdorff, 2012) integrate innovation within its societal and natural environments, and they highlight inclusiveness dimensions such as democratization of innovation and relevance to economic development (Carayannis & Campbell, 2012).

Innovation for development and innovation for sustainable development emphasize society and the physical environment respectively. With regards to economic development, the potential of science and innovation to benefit developing countries has long been recognized, with policy programs in place since the 1950s and 60s (Brook et al., 2013) and an extensive literature on technology transfer from developed to developing countries (Reddy & Zhao, 1990). Over time, such policies were viewed more critically. A key criticism relates to the conceptualization of developing countries simply as "recipients" of technology, and the related implementation of programs that limited local engagement to the application of existing technologies, rather than meaningful engagement in the innovation process. As a result, policies began to focus more on building scientific and technological capacity and infrastructure (Brook et al., 2013).

More recently, however, and in parallel to the consideration of grand challenges in the innovation context, an

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emerging literature has renewed its focus on innovation for development – as compared to science and technology capacity and infrastructure. This emerging perspective considers innovation occurring in developing countries – using terms such as "frugal innovation" (Lehner & Gausemeier, 2016; Zeschky et al., 2011), "reverse innovation" (Chataway et al., 2014), "Jugaad innovation", "bottom of the pyramid (BOP) innovation" (Hall et al., 2012; Prahalad, 2005), "Gandhian innovation", "empathetic innovation" and "pro-poor vs. from-the-poor", "long-tail and long-tailoring innovation", "below-the-radar innovation" – and explicitly acknowledges social contexts characterized by resource constraints and insecurities (Pansera & Martinez, 2017).

Innovation for sustainable development emerged as a literature stream in the 1990s in parallel to the increasing awareness of environmental damages and sustainability (Martin, 2016). From early publications onwards (Freeman, 1996; Kemp & Soete, 1992; Rennings, 2000), this literature did not simply focus on product innovation leading to reduced environmental impacts, but rather considered the systemic implications of designing innovation for sustainability. This concern later found an expression in the literature on sustainability transitions (Geels, 2010) – a topic addressed by several researches who also are making key contributions to the inclusive innovation literature, such as Rip (e.g., Kuhlmann & Rip, 2014) and Schot (e.g., Schot & Steinmueller, 2016).

Technology assessment has its origin in the requirement of developing "an earlier awareness, an earlier warning, and an earlier understanding of what might be the social, economic, political, ethical and other consequences of the introduction of a new technology into the society or a substantial expansion of an existing technology" (Tran & Daim, 2008), in particular for policy purposes in the United States. This stream of work was initiated in the late 1960s, and a range of tools was developed with varying foci, all of which involved foresight and a priori assessments. One particularly important stream of this research was developed in the context of health research to assess the potential health impacts of new technologies a priori. Another widely applied stream of research resulted in various forms of life-cycle assessments for environmental impacts. Initially, the consideration of stakeholders in technology assessment was limited to experts assessing the impact on various stakeholder groups (van Lente et al., 2017), but more recent methods of technology assessment emphasize the importance of including stakeholders in the assessment of technologies (participatory technology assessment: Sclove, 1995, 2012; Joss & Bellucci (2002), and also in the creation of technologies themselves (constructive technology assessment: Schot & Rip (1997).

Appropriate technologies is another concept that emphasizes the impacts of technologies. Building on the seminal work "Small is Beautiful" by Schumacher (1973), a flourishing community of practice and academic literature developed, focusing first on inventing more inclusive technologies, and then on implementing them. Pointing out that global research and development was highly concentrated in high-income economies, the appropriate technologies movement highlighted how the resulting technologies inadequately met the needs of the poor (Chataway et al., 2014). Although well-intentioned, the resulting technologies did not find broad uptake (Kaplinsky, 2011), and the appropriate technologies movement is generally considered a failure (Papaioannou, 2014), although its ideas have had a strong influence on many of the trends and streams of literature discussed here.

Responsible research and innovation (RRI) has emerged in the context of policy pressures on research and innovation to address societal concerns (Strand et al., 2015; van Lente et al., 2017; von Schomberg, 2012, also note the link with technology assessment: Delvenne, 2017; van Est, 2017; van Lente et al., 2017). RRI "is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products(in order to allow a proper embedding of scientific and technological advances in our society)" (von Schomberg, 2012).

The discourse on responsible innovation emerged particularly in the context of developments in nanoscience and nanotechnology research, and from an intent to consider societal implications and stakeholder interests early on. At that time, the difficulties surrounding genetically modified organisms were still recent and evolving, and the development of responsible innovation concepts aimed to ensure consideration of downstream effects early on in the process (Owen et al., 2013).

The inclusion of broad groups of stakeholders and potential consequences is central to RRI (Martin, 2013; Owen et al., 2012), and one framework explicitly contains "inclusion" as a dimension of RRI (Stilgoe et al., 2013). This work will be discussed in more detail in the following section.

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In addition, *broader trends in the innovation literature* have recently challenged existing paradigms of innovation and have had far-reaching influence not only on how innovation is perceived. Open source software (von Hippel & von Krogh, 2003), open innovation (Chesbrough, 2003), and open science (Partha & David, 1994) hold the potential of increased collaboration and inclusiveness. However, experience shows that sustained societal benefits can only be achieved under all three paradigms if intellectual property is managed carefully, and successful collaborator communities have developed sophisticated standards and practices to systematically protect and reveal specific aspects of science and technologies. Especially the open source and open science movements often feature ambitions of increased inclusiveness both in the creation of innovation and in expanding access to innovation, but efforts to include socially diverse groups tend to require substantial efforts and are not very common to date.

User innovation, the democratization of innovation (von Hippel, 2005), and grassroots innovation (Fressoli et al., 2014; Smith et al., 2014) highlight the role of users as active participants in the innovation process. To round out this review, social innovation (Benneworth et al., 2014; Cajaiba-Santana, 2014) and entrepreneurship (Austin et al., 2006) emphasize the achievement of social outcomes and the integration of excluded groups within the innovation process, and "social innovation is specifically focused on the change of norms, regulations and cognitive frames with a view to improved social practices" (Ziegler, 2015).

Inclusive Innovation

The above description of relevant fields of research suggests that researchers approach the topic of inclusivity from a range of perspectives. In particular, inclusivity in terms of considering consequences of innovation is an important theme, and it emphasizes that innovation does not only lead to economic outcomes, but also to social and environmental outcomes. Within this general context of increased awareness of the social and environmental context of innovation, there are several developments that focus specifically on inclusive innovation or innovation for inclusion.

Inclusive innovation proper

The initial and most widely recognized definition of inclusive innovation refers to the economic development context, and specifically to poverty alleviation and bottom-of-the-pyramid considerations (Chataway et al., 2014). From this starting point, most recent definitions of inclusive innovation have extended the definition more broadly to include generally excluded groups of society:

> "Inclusive innovation is the means by which new goods and services are developed for and by marginal groups (the poor, women, the disabled, ethnic minorities, etc)." (Foster & Heeks, 2015)

> "[T]he development and implementation of new ideas which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society." (George et al., 2012)

Using these definitions, the concept of inclusive innovation may seem limited to ensuring excluded groups of society are considered as customers, and maybe producers of innovations. However, the central tenet of this article is that such an interpretation would be overly simplistic and, based on prior experience and current statistics on exclusion, not likely to be effective. This recognition has given rise to the current academic and policy interest in inclusive innovation. The framework proposed below will outline four dimensions of inclusiveness and show that even the concept of including groups within the innovation process can take many forms. For example, inclusion can be conceptualized as consideration as potential customers, participation in the innovation process, and contribution to the evolution of innovation and societal systems (Foster & Heeks, 2015; Fressoli et al., 2014).

Innovation for inclusive growth

Some authors use the terms "inclusive innovation" and "innovation for inclusive growth" interchangeably (George et al., 2012), especially where the context is economic development or bottom-of-the-pyramid considerations. However, many other authors make it clear that "inclusive growth" is a certain type of economic growth, which would consequently mean that inclusive innovation by this definition would be innovation targeted primarily at economic outcomes for certain demographics.

As we will argue in more detail below, retaining the broader consideration of social and environmental outcomes and inclusiveness along other dimensions is central to the concept of inclusive innovation. In that context, the consideration of innovation for inclusive growth does, however, provide an important delineation of circumstances under which the economic outcomes of innovation can be considered as inclusive.

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Table 1 provides some of the definitions commonly used in the innovation for inclusive growth literature.

Klasen (2010) provides an extensive discussion of options to define inclusive growth. Key distinctions are whether only income is considered, or whether non-income dimensions are also included, and whether growth can be considered inclusive if it benefits all societal groups equally, or whether inclusiveness of growth necessarily required the reduction of inequalities.

The broad interest in innovation for inclusive growth by authors from several fields (Ali & Son, 2007; Carayannis & Rakhmatullin, 2014; George et al., 2012; Hall et al., 2012; Mazzucato, 2013; Planes-Satorra & Paunov, 2017) has led to a slight blurring of definitions between inclusive innovation and innovation for inclusive growth. However, conceptually, innovation for inclusive growth is clearly anchored in the economic growth literature and as such only addresses a small subset of the issues raised by inclusive innovation.

Table 1. Definitions of inclusive growth

Definition	Source
"growth that not only creates new economic opportunities, but also one that ensures equal access to the opportunities created for all segments of society, particularly for the poor."	Ali & Son (2007)
"economic growth that creates opportunity for all segments of the population and distributes the dividends of increased prosperity, both in monetary and nonmonetary terms, fairly across society"	Planes-Satorra & Paunov (2017) (OECD)
"More formally, an inclusive growth episode requires - positive per capita income growth rates; - primary income […] growth rates for predefined, disadvantaged groups […] at least as high as growth rates for per capita incomes, indicating that such groups have been able to participate in the growth process at least proportionately; and - expansions of non-income dimensions of well-being that exceed that average rate for pre-defined disadvantaged groups […]; this would ensure that an income growth episode was disadvantage reducing."	Klasen (2010)

Definition within responsible research and innovation

Research on RRI has developed several frameworks and methods to ensure and assess responsibility within science, technology, and innovation contexts. One framework in particular, that of Stilgoe and colleagues (2013), makes explicit reference to inclusiveness. The framework consists of four closely related dimensions that are important characteristics of responsive innovation. The first dimension, anticipation, requires ex-ante consideration of not only the potential of new technologies, but particularly also the risks new technologies may pose. Beyond technology assessments and forecasting, it also requires early involvement of the public to ensure pathways of technological development are aligned with societal expectations and needs. The second dimension, reflexivity, highlights that responsibility demands engaging critically with institutional practices within science, and with the value systems that underlie scientific and technological creation. The third dimension, inclusiveness, reflects the waning authority of expert, top-down science and policy development, and suggests that legitimacy needs to be established through involvement of broad stakeholder groups and the public. The last dimension, responsiveness, emphasises that responsible innovation requires a "capacity to change shape or direction in response to stakeholder and public values and changing circumstances" (Stilgoe et al., 2013).

This framework is also adopted in European Commission work on measurement of RRI (Strand et al., 2015), which also adopts the von Schomberg (2012) definition. Although they do not focus solely on inclusiveness, the measurement categories outlined by Strand and colleagues (2015) give some indication of the kinds of inclusiveness the European Commission is focused on. The categories are: public engagement, gender equality, science education, open access, ethics, governance, sustainability, and social justice/inclusion.

Clearly, these definitions extend the concept of inclusiveness beyond simply inclusiveness of economic out-

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comes as the innovation for inclusive growth framework does. As we will argue below, the implications of consequent consideration of public engagement, gender equality, and sustainability – to name some of the key dimensions – suggest that more than economic growth needs to be considered.

This conceptualization of inclusive innovation – especially when it is assumed also to be anticipatory, reflexive, and responsive – addresses more of the concerns raised in the initial definition of inclusive innovation, but retains a narrow focus on technological innovation.

Summary

The preceding definitions of inclusive innovation are consistent in that they require the inclusion of previously excluded groups. The difference then lies in the way in which excluded groups are to be considered and to which extent the various dimensions of inclusion or exclusion are thematized in each model. Indeed, the literature places great emphasis on the nature of inclusion, highlighting the need of inclusion not simply as users or consumers of innovations, but also as producers, and designers of innovation (Chataway et al., 2014; Foster & Heeks, 2015; Heeks et al., 2014; Pansera & Martinez, 2017).

A second differentiating element is the type of innovation activities considered, and especially the role of technology in this regard. Much of the literature on inclusive innovation is deeply rooted in the science and technology literature, and as such has a strong bias towards good, service, or process innovations based on scientific or technological advances. However, numerous authors have challenged this narrow definition. Joseph (2014) argues that, in order to achieve the goal of inclusion, the focus needs to extend past the high-technology sectors, which are traditionally considered highly innovative, to also consider innovation in labour-intensive and labour-extensive sectors. Similarly, Foster and Heeks (2015) note that it should include sectors of particular importance to marginalized populations, such as health, education, and small-scale agriculture. However, to be truly inclusive, broader definitions are required. Paunov (2013) includes "not only R&D-based innovation but also innovation based on practice rather than formal R&D, and social and business innovations", and Dubé and colleagues (2014) include dimensions such as organizational, social, financial, and institutional innovation.

One of the drivers behind inclusive innovation is the social well-being of marginalized populations. Economic growth can be expected to alleviate a number of social issues, but history has shown that consideration of only economic outcome indicators is prone to lead to increasing inequalities and has created a strong motivation for the current trends towards more inclusive innovation. Thus, at a minimum, distributional effects of innovation need to be considered (Altenburg et al., 2009), but the more likely implication of inclusive innovation is that broader outcomes, such as quality of life (Bergeron et al., 2012), specific social outcomes, as well as environmental outcomes, need to be considered.

Finally, reflexivity with regards to the innovation process is a key emerging theme within the inclusive innovation literature. There is a clear call to consider innovating how we innovate (Dubé et al., 2014), even to the extent of challenging fundamental assumptions of the innovation process – such as the pursuit of consumption growth (Soete, 2013), competition between national systems of innovation (Schot & Steinmueller, 2016), and even assumptions that remain to be challenged as a consequence of the inclusion of new actors in the innovation process (Kuhlmann & Rip, 2014).

Dimensions of Inclusive Innovation

The summary above suggests that there are four dimensions – who, what, why, and how – along which innovation needs to be inclusive: people or groups of people included, the types of innovation activities included, a broad range of outcomes and benefits to be captured, and the governance mechanisms of innovation. In addition, the previous subsections highlight that inclusiveness cannot be superficial if it is expected to lead to positive impacts on inclusion – whether these are economic, social, or environmental outcomes.

Who: People

To answer the question of who should be included in innovation activities, two questions need to be answered: "Which groups of people should be included?" and "How should they be included?"

With regards to the first question – which groups to include – the literature refers to traditionally disadvantaged, marginalized, or excluded groups, although the main focus has been on the poor in developing countries, commonly referred to as the bottom of the pyramid (BOP) (Heeks et al., 2014). The definition of BOP is relatively consistently defined by incomes of $1.25USD per day or similar cut-offs (Chataway et al., 2014; Heeks et al., 2014). Translating the concept of inclusive innov-

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ation to countries other than developing countries, authors often rely on the concept of social exclusion (Sen, 2000) to define marginalized or excluded groups. Commonly targeted groups for inclusive innovation interventions include women, youth, the disabled, ethnic minorities, and informal sector entrepreneurs (Heeks et al., 2014), or those defined by industrial or territorial boundaries (Planes-Satorra & Paunov, 2017).

However, there is a risk that this approach will focus only on groups that historically faced social exclusion, and that it may ignore groups that are or will be affected by arising societal, technological, and broader innovation trends. A much-debated example demonstrating the importance of this is the pressure exerted by the introduction of artificial intelligence into the workplace. Innovations based on artificial intelligence have begun to replace jobs and are projected to substantially transform the labour landscape in coming years. The types of jobs affected will not be based on historical social exclusion, but rather on the potential of artificial intelligence to outperform humans. In fact, one of the earliest groups affected by artificial intelligence is financial traders on the stock market. Arguably, these were highly coveted jobs in the financial industry, with a high representation of individuals of high social inclusion status. Current projections further suggest that many of the jobs anticipated to become obsolete by this wave of innovation are well-paying, secure jobs, often currently held predominantly by men, such as jobs in the manufacturing sector, truck drivers, etc.

Thus, inclusiveness in the context of innovation and innovation policy needs to be both anticipatory and historically based, and ensure that not only historically excluded groups are considered, but that groups currently under pressure or predicted to be negatively affected by innovation trends are carefully considered in innovation conversations. It also needs to take into account that the means of social exclusion are changing, through widespread digitization and the use of big data analytics to define included and excluded populations.

With regards to the second question – how these groups should be included – Heeks and colleagues (2013) propose a framework with six levels. At the most basic level, *intention,* innovations address needs, wants, or problems of the focal group. The second level, *consumption,* refers to the focal group as users of an innovation, implying that the group can access and afford the innovation and has the motivation to adopt it. The third level, *impact,* sees an innovation as inclusive if it has positive impact on the focal group. Such impact is broadly defined and can include economic perspectives, well-being, capability increases, and others. Level four, *process,* sees inclusion of the group in the development of the innovation, with sub-levels distinguishing between being informed, being consulted, collaborating, being empowered, and controlling the development of innovation. Level five, *structure,* goes beyond individual innovations and focuses on the inclusiveness of institutions, organizations, and relations that make up innovation systems. Finally, level six, *post-structure,* acknowledges that innovation occurs within a frame of knowledge and discourse, which serves as the foundation of power distributions at the source of societal outcomes. Inclusive innovation in its most meaningful definition would occur in a context where diverse knowledge frameworks of all groups determine the structures, processes, and manifestations of innovation.

To illustrate these concepts, questions regarding the level of inclusion have been debated in the context of the inclusion of women in science and technology and more specifically in innovation. Nählinder and colleagues (2015) conducted a study on definitions of innovation and gender distribution of innovation characteristics. Notably, they found that women were less innovative than men using common definitions of innovation. However, when women's perspectives were integrated into the conceptual framing of innovation (i.e., they were included at level six, post-structure, in the model by Heeks and colleagues [2013]), such differences disappeared. Similar needs for post-structural inclusion can be expected with regards to any group to be included, which, of course, raises the difficult question of how to accomplish transitions to more inclusive frameworks without creating new dimensions of exclusion.

Another consideration from the gender context, which may hold true on a much broader level, is the consideration of mutual influences between existing innovation systems and newly included groups. At a time when women were increasingly involved in both consumption and production of science and technology, Franklin (1985) asked: "Will women change technology or will technology change women?". With regards to inclusion of economically disadvantaged groups, evidence (Chataway et al., 2014) suggests that inclusion of subsets of the bottom of the pyramid does not lead to systemically improved consideration of poverty.

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Thus, we argue that inclusive innovation has to be anticipatory in its definition of groups to be included and open to engage at the structural or post-structural level of inclusion to be effective.

What: Activities

Current and past academic and policy conversations on inclusive innovation focus on science and technology-based innovations, and their commercialization pathways. Commonly referenced examples for inclusive innovation activities include "the provision of grants to researchers from disadvantaged groups, the deployment of programmes to popularise science and technology, the provision of micro-credit to entrepreneurs and the provision of grants to firms locating their R&D activities in peripheral regions" (Planes-Satorra & Paunov, 2017).

As the fundamental concern of inclusive innovation lies outside immediate economic growth considerations, it seems counterproductive to continue to only consider activities aiming at the commercialization of new products or processes as innovation. Even within the mainstream innovation literature, definitions of innovation are increasingly broad. One of the broader definitions has been proposed by the European Commission (1995): "innovation is taken as being a synonym for the successful production, assimilation and exploitation of novelty in the economic and social spheres".

Much earlier, in the early nineteenth century, Robert Owen aimed to address social concerns caused by the large mills in England's textile industry by introducing the organizational innovation of creating smaller mills that empowered the workforce and supported smaller communities (Chataway et al., 2014). Almost two centuries later, the combination of free and paid eye care offered in India through the Aravind Eye Hospital (www.aravind.org) also addresses social concerns, but we might consider this innovation a fundamental business model innovation – combining process, some product innovation, organizational, and financial innovations.

At this time, a promising framework by Dubé and colleagues (2014) refers to the combination of technological innovation, organizational innovation, social innovation, financial innovation, and institutional innovation as "convergent innovation", although future work would be useful to better position appropriate frameworks within the current proliferation of types of innovation.

Why: Outcomes

Many contributions in the inclusive innovation literature in the broad sense begin by outlining the transition of policy expectations towards innovation from narrowly focused contributions to economic growth, through inclusion of context- and field-specific outcomes, such as health, environmental, or social outcomes, to the current expectations of innovation policy to contribute to solving grand societal challenges (Kallerud et al., 2013; Kuhlmann & Rip, 2014).

Capturing such outcomes of innovation is challenging (Martin, 2016) and has been subject to much academic research (refer to Strand et al. [2015] and Dubé et al. [2014] for initial references). Where health and environmental benefits are considered, there is also often a tendency to only capture positive impacts, leaving negative impacts among externalities not integrated into analysis and decision making.

In addition, the goal of inclusiveness complicates the consideration of outcomes even further, as the goal is often not only to improve overall health or social outcomes, but also to achieve greater equality in the distribution of outcomes. To date, distributional effects of both policies and specific innovations are rarely investigated (Altenburg et al., 2009), and should focus both on risks and benefits (Cozzens et al., 2009).

Finally, wholesome consideration of environmental impacts in particular makes it clear that the current paradigm of innovation is fundamentally tied to a "consumption growth path, which in its environmental impact and ecological footprint will be unsustainable in the developed world and increasingly so in the rapidly emerging country world" (Soete, 2013; also see Soete, 2010).

How: Governance

Most authors contributing to the literature on inclusive innovation acknowledge that inclusiveness is likely to have some implications on the institutions, structures, and mechanisms governing how innovation is implemented and conceptualized. Conceptualizations of these impacts range from the involvement of stakeholders in innovation policy, through changes in innovation processes and the need for institutional flexibility within innovation systems, to a vision for transformational changes to innovation systems.

The development of governance mechanisms allowing the inclusion of stakeholders in the innovation process

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is one of the more obvious starting points. Issues considered in this regard are how to align stakeholder interests (Edler & Fagerberg, 2017; Kemp & Never, 2017), how to develop coordinated policy mixes (Kivimaa & Kern, 2016; Rogge & Reichardt, 2016), and how to facilitate alignment of policy mixes with stakeholder interests (Schillo et al., 2017). In many countries, mechanisms exist to include stakeholders for example through various advisory councils (Edler & Fagerberg, 2017) and consultation processes. However, the stakeholders invited to join such councils or participate in consultations are typically representatives of key organizations along existing value chains. As such, this kind of inclusiveness tends to reinforce existing structures of inclusion and exclusion rather than offer opportunities for the inclusion of excluded groups.

A more fundamentally inclusive consideration would not only question such existing structures, but also the processes currently used to innovate. For example, an emerging literature challenges the importance of speed in the innovation process (Vogt, 2016; Woodhouse, 2016) and suggests that achieving societal outcomes will depend more on the "capacity to innovate in the way we innovate than on accelerating technology development" (Dubé et al., 2014).

Substantial changes to the way innovation occurs will also require institutional flexibility in the innovation system (Andersen & Johnson, 2015) along the lines of the better governance principles and processes called for by the RRI literature (Owen et al., 2012; Stilgoe et al., 2013; von Schomberg, 2012), including "anticipation, participation, deliberation, transparency—to ensure that the process and direction of R&D and innovation better take into account societal preferences and concerns around ethics, sustainability" (Edler & Fagerberg, 2017).

Perhaps most importantly, however, inclusiveness in the broad sense outlined in all four dimensions presented here is likely to imply transformative change within innovation systems (Schot & Steinmueller, 2016). As Kuhlmann and Rip (2014) emphasize, inclusive innovation is not simply a funding priority within R&D policy, but rather "open-ended missions, and missions concerning the socio-economic system as a whole, even inducing (or requiring) system transformation" (Kuhlmann & Rip, 2014).

Conclusion

This article has provided an overview of conceptualizations of inclusive innovation and presented a framework of four dimensions of inclusivity. It shows that inclusivity is not simply a matter of selling innovative products to socially excluded groups, or integrating small numbers of individuals from excluded groups within dominant innovation structures and processes. As previous experiences with appropriate technologies and BOP programs suggest, complementing the existing system with additional BOP programs will not solve the issue of poverty, nor can it address the globally increasing inequality. Without increased reflexivity, the current paradigm of innovation can be expected to reinforce current structures in many areas. To achieve any different outcomes, we need to develop the capacity to innovate how we innovate (Dubé et al., 2014).

It is clear that much remains to be discovered about inclusive innovation. This is not only the case due to a dearth of empirical data and even measurement frameworks, but also because inclusive innovation policy and practice require a fundamental openness to experimentation and adaptation. Perhaps most importantly, empirical and further theoretical development needs to involve groups and viewpoints not currently represented in the inclusive innovation literature. This literature has been heavily influenced by a relatively small group of primarily white men and some women – a limitation also affecting this article. From this perspective, the framework proposed in this article presents a step towards greater inclusiveness. Future theoretical or empirical academic work by more diverse groups of authors and practitioners may provide important new dimensions or reconceptualizations. In addition, implementation of this framework into policy and program development should be preceded by its critical evaluation by all relevant stakeholder groups and careful integration of feedback received.

Although the concept of holistic inclusive innovation has been juxtaposed to the current dominant innovation structure throughout this article, it is important to note that many of the drivers towards increased inclusivity are in place, and many examples exist of successful implementation of inclusive innovation initiatives or programs (Goel, 2011). Indications are that even if the transition towards inclusive innovation will neither be effortless nor automatic, inclusive innovation provides a plausible scenario for increased social and environmental sustainability on a global level.

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Acknowledgements

The authors would like to thank Louise Earl and Jeff Kinder for insightful discussions on inclusive innovation.

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Inclusive Innovation in Developed Countries: The Who, What, Why, and How

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Citation: Schillo, R. S., & Robinson, R. M. 2017. Inclusive Innovation in Developed Countries: The Who, What, Why, and How. *Technology Innovation Management Review,* 7(7): 34–46. http://timreview.ca/article/1089

Keywords: inclusive innovation, framework, inequality, developed countries, social exclusion

Comparing the Entrepreneurial Ecosystems for Technology Startups in Bangalore and Hyderabad, India

M H Bala Subrahmanya

> *"The emergence of [the] start-up wave in India is a relatively new phenomenon. India is today undergoing a fundamental shift with entrepreneurship and innovation being primary catalysts in job creation and solving everyday problems."*
>
> Praneeth Rao, Vaibhav Goyal, Agrima Singh, and Simrat Singh
> International Policy Analysis Network Research Team

Technology startups are gaining increasing attention from policy makers the world over because they are seen as a means of encouraging innovations, spurring the development of new products and services, and generating employment. Technology startups tend to thrive when inserted in a conducive entrepreneurial ecosystem. Therefore, ecosystem promotion is being given increasing policy support. However, the emergence and structure of entrepreneurial ecosystems for technology startups have hardly been traced and examined in detail. In India, Bangalore occupies a unique position in the startup world, and Hyderabad is fast emerging as one of the promising startup hubs in the country. Given this background, we set out to explore and examine the structure, evolution, and growth of ecosystems for technology startups in the context of Bangalore and Hyderabad. Both the ecosystems emerged due to the initial foundation laid in the form of government–industry–academia triple helix and their interactions leading to the emergence of a modern industrial cluster followed by an information technology and biotechnology cluster, which then led to R&D cluster serving both the cities. These three clusters together, gradually and steadily, facilitated an entrepreneurial ecosystem for technology startups to emerge. The ecosystem operates within the triple helix model and has a nucleus with two outer layers: i) an inner layer of primary (indispensable) factors and ii) an outer layer of supplementary (secondary) factors. Through the analysis of the experiences of Bangalore and Hyderabad and their ecosystem evolution, its structure, and components, we derive key lessons for others within and beyond India.

Introduction

Entrepreneurial ecosystem development is a process occurring over a period of time. Successful ecosystems are highly developed and matured. The two often-cited benchmarks in this regard are Silicon Valley and Israel, which are uniquely identified for their success in entrepreneurship development and for generating in one year, more successful startups than any other nation would have done in years or decades (Arruda et al., 2013). If the structure of an ecosystem has to be understood for policy implications, it would be appropriate to probe how each ecosystem originated and developed over time, as this has not been adequately explored in the context of entrepreneurial ecosystems for technology startups, as of now (Motoyama & Watkins, 2014).

Today, India has been recognized as one of the key potential sources of technology-based startups in the global economy (Gai & Joffe, 2013), and it currently ranks third globally, in terms of number of existing startups and number of startup exits (NASSCOM, 2015; *Times of India,* 2016). Within India, its "Silicon Valley", Bangalore, was considered to be one of the nine Interna-

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tional Startup Hubs outside the United States (Pullen, 2013). Further, recently it ranked 15th among the 20 cities with the best ecosystems for startups worldwide (Startup Genome, 2015). Hyderabad is one of the major upcoming startup locations in the country (NASSCOM, 2015), and it is a close competitor with Bangalore in the spheres of information technology, biotechnology, and R&D-intensive industries (Das, 2015). Given this context, we set out to examine how these two ecosystems have emerged over time and to understand the prevailing structures of the ecosystems for technology startups in these two cities.

The emergence of technology startup hubs in both Bangalore and Hyderabad is a very recent phenomenon. However, the foundation for its emergence was laid decades ago, after India's independence in 1947. These two metropolitan cities host industrial clusters comprising modern manufacturing industries of varying sizes and are also home to several publicly-funded R&D institutions and high-quality public and private educational institutions. Both cities have pro-industry regional governments, which have formulated and implemented regional (state-level) industrial policies periodically for the development of industries and infrastructure. Thus, both have the much needed industry–institute–government combination for the emergence of a conducive ecosystem for startups.

In this article, we trace the evolution of the entrepreneurial ecosystems in the two cities, with a historical perspective since India's independence, and we examine the current structures of these ecosystems. We aim to derive some general lessons from the experiences of these two technology startup hubs of India. But at the outset, we would like to broadly define the two important concepts of this article, namely, startups and ecosystems. A startup is, in general, defined as a new venture with no previous history of operations (Bala Subrahmanya, 2015). Such new ventures suffer from the liability of newness because they are unfamiliar and without any precedence (Certo, 2003). In terms of age, they are age-zero firms or "infants" (i.e., they are less than one-year old) (Kane, 2010). Startups exclude existing enterprises that have been acquired by new ownership, or those inherited by younger generations from the older ones, or "industry spin-offs" where a large firm has a control, directly or remotely, or franchisees of any form (Bala Subrahmanya, 2015). Similarly, an ecosystem in the context of startups, in general, may be defined as a system comprising prospective as well as currently operating startup entrepreneurs, their mentors, financiers, trainers, large firms that provide market support, organizations (universities, institutions, etc.), and government policy makers that support and promote startups, and their interrelationships and interactions.

Objectives and Methodology

This article has two specific research questions:

1. *How did the entrepreneurial ecosystems of Bangalore and Hyderabad emerge?*

2. *What are the structures and components of these entrepreneurial ecosystems?*

To answer these questions, we first reviewed the relevant empirical literature and then conducted personal interviews with ecosystem stakeholders to understand the structure of the ecosystems and the interactions between the various actors.

Our empirical literature survey, which focused on the diverse components of entrepreneurial ecosystems in different parts of the global economy, clearly identified some common elements without which an entrepreneurial ecosystem may not come into existence or may not be effective and successful. The key elements or components of an entrepreneurial ecosystem identified and emphasized by the various empirical studies are presented in Table 1.

Based on the literature survey, and our identification of key stakeholders under different domains of the entrepreneurial ecosystems in both Bangalore and Hyderabad, we prepared an open-ended questionnaire and identified a set of about 50 stakeholders for each city. We approached those identified stakeholders who responded positively to our request and interviewed each one of them personally (51 in Bangalore and 38 in Hyderabad) for about one and half hours during the period from August 2015 to January 2016 (Table 2). An open-ended questionnaire formed the basis of the interviews, which contained 10 questions covering topics such as:

- definition of a high-tech startup
- characteristics of a high-tech startup
- components of an ideal ecosystem for high-tech startups (in India)
- ranking of the identified components

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Table 1. The entrepreneurial ecosystem: components and their roles

No.	Components	Role and Importance	Identified Studies
1	Entrepreneurship	At the core of the ecosystem for the birth, growth, and exit of startups.	• Isenberg (2011) • Feld (2012) • Arruda et al. (2013) • Aleisa (2013) • Foster & Shimizu (2013) • Piscione (2013) • Anjum (2014) • Dale & Zell (2014) • WEF (2014) • Bala Subrahmanya (2015) • Stangler & Masterson (201 • Krajcik & Formanek (2015 • Sean (2015) • Haines (2016) • Hemmert et al. (2016) • Aaltonen (2016)
2	Markets	Early product adopters, repeat customers, networks, and multinational corporations.	
3	Finance	Angel investors, private equity firms, venture capitalists, public capital markets for initial public offerings, and debt instruments.	
4	Human Resources	Labour force, technical workforce, and managerial talent.	
5	Education & Research	Institutions that produce non-graduate and graduate workforce, technical and managerial talent, innovations, entrepreneurial training, etc.	
6	Government (regulatory framework & policies)	Favourable laws and regulations for tax incentives, venture capital, bankruptcy, property rights, labour, and exits public research institutions.	
7	Large Companies (including multinational corporations)	As customers, sources of entrepreneurship, nurturers of startups through accelerators, sources of technical and managerial workforce, investors, technology providers, acquirers of startups.	
8	Mentors/Advisors	Technical and managerial advice for startup creation, stability, growth, and exits.	
9	Support Institutions	Accelerators, technology business incubators, soft infrastructure (e.g., professionals such as lawyers and accountants), and hard infrastructure (e.g., telecommunications, transportation, and logistics)	
10	Cultural Support	Tolerance of risk, failures, support for innovation, creativity, drive and hunger for achievements; higher social status for entrepreneurs; respect for wealth creation.	
11	Media	Publicizing: startup creations, its pre-requisites, support available, failure consequences, and achievements of success	
12	Immigration of Talent	Sources of entrepreneurship, human resources, advisors/mentors, finance, support networks, etc.	

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Table 2. Entrepreneurial ecosystem stakeholders in Bangalore and Hyderabad interviewed for this study

Stakeholder Type	Bangalore	Hyderabad
Startup Entrepreneurs	17	17
Government Officials	1	1
Large Enterprises (multinational corporations and domestic large firms)	7	2
Professors	3	6
Financiers (angels, venture capitalists, etc.)	7	4
Accelerators, Incubators, and Co-Working Spaces	7	6
Industry Associations	3	1
Mentors	3	1
Media Representatives	3	0
Total	**51**	**38**

- the importance of quality of components, quantity of components, and interaction among components for determining the effectiveness of an ecosystem
- whether Bangalore/Hyderabad has the best ecosystem in India
- factors that led Bangalore/Hyderabad to emerge as one of the best startup hubs in India
- significant components of the ecosystem for high-tech startups in Bangalore/Hyderabad
- components that are lacking or have a weaker presence in Bangalore/Hyderabad
- the level of interaction between the components in the ecosystem of Bangalore/Hyderabad

The author took down notes as he interacted with the stakeholders of the ecosystem. The information gathered through the personal interviews and the review of relevant literature formed the basis of the analyses to answer the two research questions.

Phases of Evolution in the Entrepreneurial Ecosystems of Bangalore and Hyderabad

Both Bangalore and Hyderabad are the capital cities of their respective states, namely, Karnataka and Andhra Pradesh/Telangana in southern India. These are two of the metropolitan cities of India and are industrial/commercial/institutional hubs of the country. According to the Jones Lang LaSalle City Momentum Index (Clarke-Billings, 2017), Bangalore is the most dynamic city in the world whereas Hyderabad is the fifth most dynamic city in the world. Table 3 provides some key statistics on both of these cities.

After India's independence in 1947 (for Bangalore) and after the integration into Indian Union in 1948 (for Hyderabad), the foundation for the evolution of an entrepreneurial ecosystem was laid in both the cities. This was primarily driven by public policies initiated by the national government and were characterized by the location and growth of central public sector undertakings (CPSUs) followed by industrial estates for modern small-scale industries and establishment of national government-funded public R&D institutions, as well as public and private educational institutions (Department of Gazetteer, 1996; Sudhira et al., 2007). This foundation resulted in the emergence of the much-needed regional innovation system, led by the "triple helix" comprising university–industry–government and their interactions, as propounded by Etzkowitz (2003). In the triple helix model, the State (national government) played a dominant role, driving industry and academia for national/regional development, resembling what Etzkowitz and Leydesdorff have described as a "statist" model (2000). The development of such a regional innovation system occurred over a period comprising almost four decades, ranging from the late 1940s to the mid-1980s. This marked the first phase in the evolution of an entrepreneurial ecosystem in both the cities (Figures 1 & 2).

The transition from the first phase to the second phase occurred rather smoothly and spontaneously beginning in the mid-1980s in Bangalore, with the entry of Texas Instruments and the origin of Bangalore-based information technology firms. The process was stimulated by the introduction of national economic reforms in 1991 and their acceleration since then, which virtually removed the entry barriers for multinational corporations in the information technology industry. This, coupled with the initiatives of regional government to strengthen the physical and virtual infrastructure as well as educational institutions, Bangalore received a

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Table 3. Bangalore and Hyderabad: comparative statistics

Characteristics	Bangalore	Hyderabad
Year of Founding	1537	1591
Area	741 km^2	650 km^2
Altitude Above Sea Level	920 m	550 m
Climate	18° C – 38° C	15° C – 40° C
Population	8.4 million	7.7 million
Literacy Rate	89%	83%
Major Industries	Information technology and biotechnology industries, manufacturing, and textiles	Information technology and biotechnology industries, and manufacturing
Universities and Institutes of National Importance	13	6
Central Government Institutes and Central Public Sector Undertakings	57	47
State Government Institutes and State Public Sector Undertakings	20	13
Scientific & Industrial Research Organizations (SIROs)	35	32
DSIR-Registered Private Sector In-House R&D Units	178	185
Private Sector R&D Units Not Registered with DSIR	104	79

Notes:
1. Population numbers and literacy rate percentages: Office of the Registrar General & Census Commissioner, India (2011) .
2. Bangalore year of founding, area, altitude, and climate: Sudhira et al. (2007).
3. Hyderabad year of founding, area, altitude, and climate: Das (2015).
4. Data on universities, government institutes, public sector undertakings, SIROs, DSIR registered R&D units, and private sector R&D units: DST (2015).
5. DSIR – the Department of Scientific & Industrial Research – is a part of the Ministry of Science & Technology, Government of India. The primary endeavour of DSIR is to promote R&D by the industries, and it grants recognition to in-house R&D units in industrial enterprises, provided they satisfy terms and conditions as stated by the DSIR.

boost to emerge as an information technology industry cluster, soon compounded by a biotechnology industry cluster, by the late 1990s. With the introduction and acceleration of national economic reforms, the role of the State (national government) declined in intensity, though regional government continued to be important, and the role of industry and academia became more important. Thus, in the triple helix model, all the three partners, namely, State, Academia, and Industry seemed to emerge as equally important, thereby resembling the "laissez-faire" model described by Etzkowitz and Leydesdorff (2000). The role of the industry shifted increasingly from central public sector undertakings to multinational corporations and domestic information technology industry firms (Figures 1 & 2).

However, in Hyderabad, the transition from the first phase to the second phase was neither smooth nor spontaneous. Though Hyderabad, similar to Bangalore, had emerged as a cluster of modern manufacturing industries by the 1980s, it was the explicit initiative taken by the State (regional government) since the late 1990s for the transformation of the city towards the creation of a knowledge society and the positive response from the multinational corporations in the information technology industry, duly supported by domestic informa-

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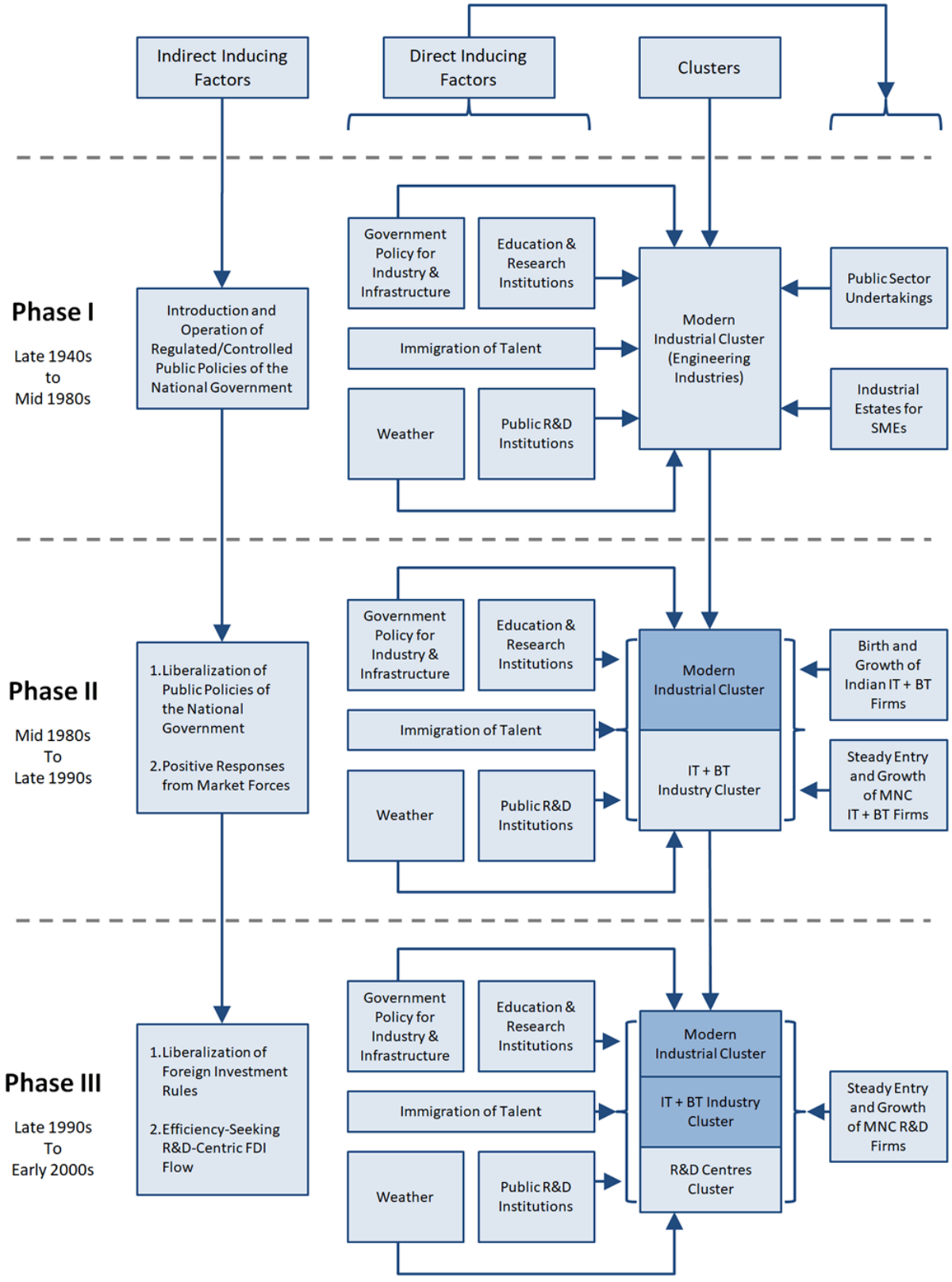

Figure 1. Bangalore: Phases in the evolution of its entrepreneurial ecosystem for technology startups

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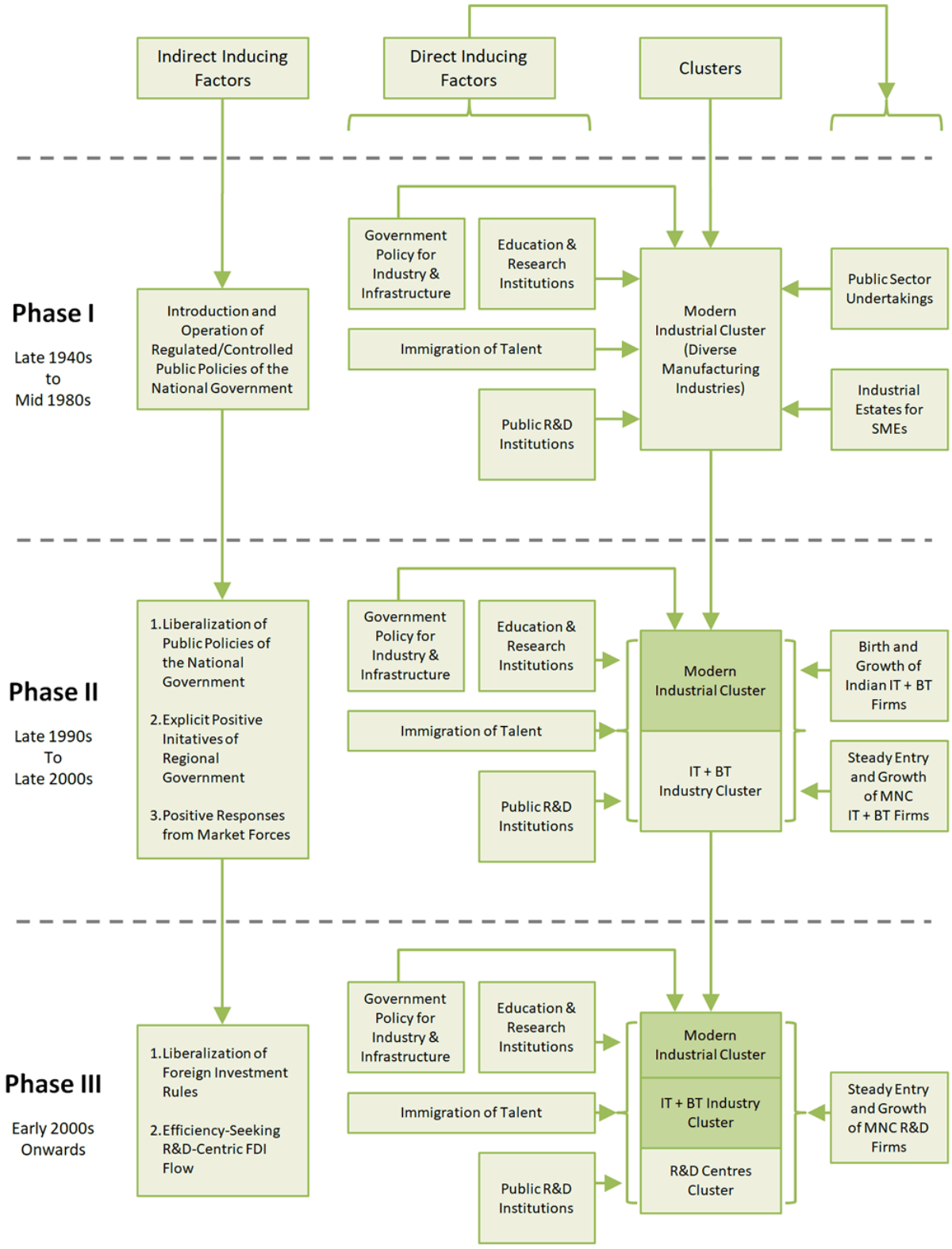

Figure 2. Hyderabad Phases in the evolution of its entrepreneurial ecosystem for technology startups

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tion technology industry firms, which led to the emergence and growth of an information technology industry cluster in the subsequent decade (Das, 2015). Further, unlike Bangalore, Hyderabad had a heavy concentration of pharmaceutical industries and a higher concentration of biotechnology industries; both had come up (in 1980s as well as 1990s) prior to the emergence and growth of the information technology industries. The State (regional government in the place of national government) continued to be the dominant partner with industry and academia, implying that the "statist model" continued to be relevant for Hyderabad, unlike Bangalore, even in the second phase. Only the role of industry shifted from central public sector undertakings to multinational corporations and domestic private firms, and the role of academia was strengthened by the addition of private sector academic institutions (Figures 1 & 2).

The transition from the second phase to the third phase, again, has taken place smoothly and spontaneously since the late 1990s in Bangalore, with more and more multinational corporations locating their R&D affiliates in the city. This, coupled with the already established publicly funded R&D institutions, facilitated the emergence of an R&D cluster. In the process, interactions through partnerships and networking initiatives between R&D affiliates of multinational corporations and information technology industry development centres, academia and government grew. Perhaps all this led to the emergence of Bangalore as one of the 46 Global Hubs of Technological Innovation (UNDP, 2001) and the more recent identification of the city by the *MIT Technology Review* as one of the eight largest technology innovation clusters in the world (*Times of India,* 2013). Considering this, Bangalore might be in the process of witnessing what Etzkowitz and Leydesdorff (2000) have described as a "balanced" triple helix model (Figure 1). Though Hyderabad, similar to Bangalore, started to attract multinational corporations to locate their R&D affiliates, it is still in the process of catching up with Bangalore as a cluster for R&D centres (Figures 1 & 2). Given this, Hyderabad might take some more time to witness a "balanced" triple helix model.

The question is, what is the relevance of the triple helix model and its different configurations for an entrepreneurial ecosystem for technology startups? It is the triple helix of university–industry–government interactions that generates knowledge and innovations (Ranga & Etzkowitz, 2013), which could lead to the emergence and growth of technology-based startups. In addition, along with technology startups, triple helix interactions provide or influence all the required components of an entrepreneurial ecosystem for technology startups such as: i) sources of entrepreneurship; ii) sources of finance; iii) market; iv) human resources; v) support structure comprising accelerators, technology business incubators, and co-working spaces, among others; vi) mentorship; vii) policy; viii) conducive culture; and ix) supportive media. From the triple helix interactions, both Bangalore and Hyderabad have witnessed the emergence of these components in varying degrees.

In addition, weather has played a distinctly positive role in the case of Bangalore. Bangalore's strong point is its favourable weather, which helps foster a culture of optimism and openness, as stated by the MIT Technology Review (Times of India, 2013). Its location over the Deccan Plateau at an altitude of more than 3000 ft above the sea level keeps it cooler than most other Indian cities, and gives it possibly the best climate among all the metropolitan cities of India. It is often stated that Bangalore enjoys a salubrious climate all through the year (Sudhira et al., 2007). This favourable weather has contributed significantly in attracting investments and technology workforce to the city on a continuous basis. Given this, it is appropriate to understand the structure of entrepreneurial ecosystems in the two technology startup hubs.

Structure and Components of the Entrepreneurial Ecosystems of Bangalore and Hyderabad

The more than six decades' growth of Bangalore, which saw the setting up of central public sector undertakings comprising modern manufacturing industries in machinery and electronics, coupled with the growth of much needed SMEs, educational institutions, public R&D institutions, followed by information technology and biotechnology industries, and then by R&D affiliates of multinational corporations, ensured the emergence and growth of triple helix model partners, namely, government, industry, and academia. This gradually but steadily led to the emergence of different components of the entrepreneurial ecosystems for technology startups. Bangalore's current entrepreneurial ecosystem for technology startups is summarized in Figure 3. The ecosystem can be broadly viewed as a system within the triple helix model comprising: i) a nucleus of technology startups and prospective technology startups, surrounded by the existence of ii) indispensable (primary) factors consisting of sources of finance including seed funds, angel investors, venture capital funds, and private equity firms; market support; human

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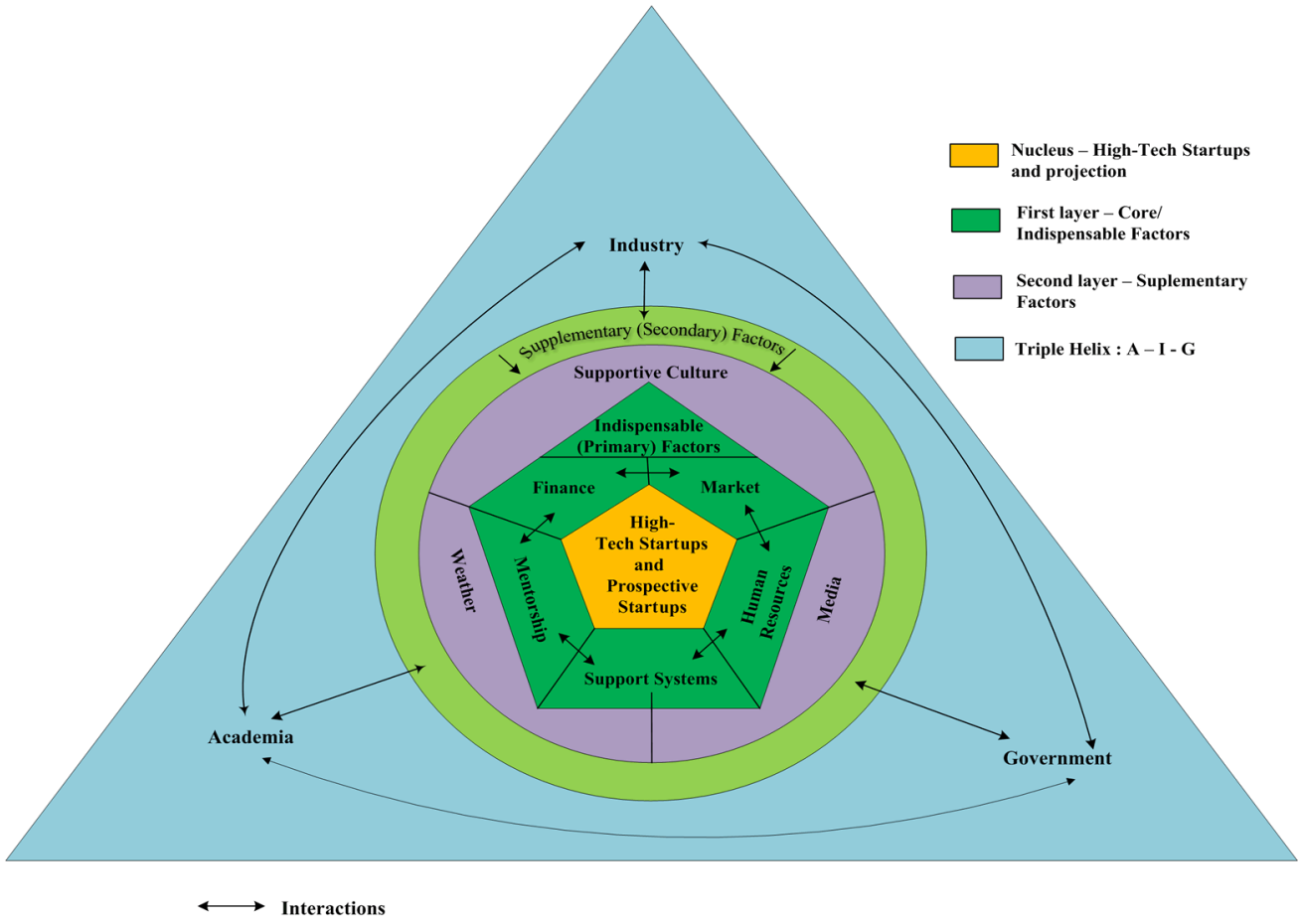

Figure 3. Bangalore: Structure and components of the entrepreneurial ecosystem for technology startups in relation to the triple helix model

resources, support systems in the form of accelerators, incubators, and co-working spaces; and technology and business mentors, and iii) supplementary (secondary) factors consisting of supportive culture (induced by constant talent immigration, supportive media and good weather).

The large base of education and research institutions in Bangalore play multiple roles in supporting and promoting the ecosystem. Karnataka state, of which Bangalore is the capital, has the third-largest concentration of professional (technical and management) education institutions and has one of the highest concentrations of universities and university-level institutes in the country (Government of India, 2016), the majority being located in Bangalore. First and foremost, these institutions generate entrepreneurial as well as human resource talent for technology startups. Second, faculty members in these institutions provide mentorship and sometimes even facilitate market support as the early adopters of startup products/services. Third, some of these institutions (such as the Indian Institute of Science, the Indian Institute of Management Bangalore, the International Institute of Information Technology Bangalore, the Institute for Bioinformatics and Applied Biology, and the National Centre for Biological Sciences) have their own technology business incubators and arrange for other support services, such as intellectual property consultancy, to nurture entrepreneurship through technology innovation commercialization, particularly among their own faculty/would-be graduates.

Large firms, similar to education and research institutions, form an indispensable part of the ecosystem for various reasons. These include central public sector undertakings, domestic private firms, and multinational corporations. First, similar to education and research institutions, they generate entrepreneurial talent as

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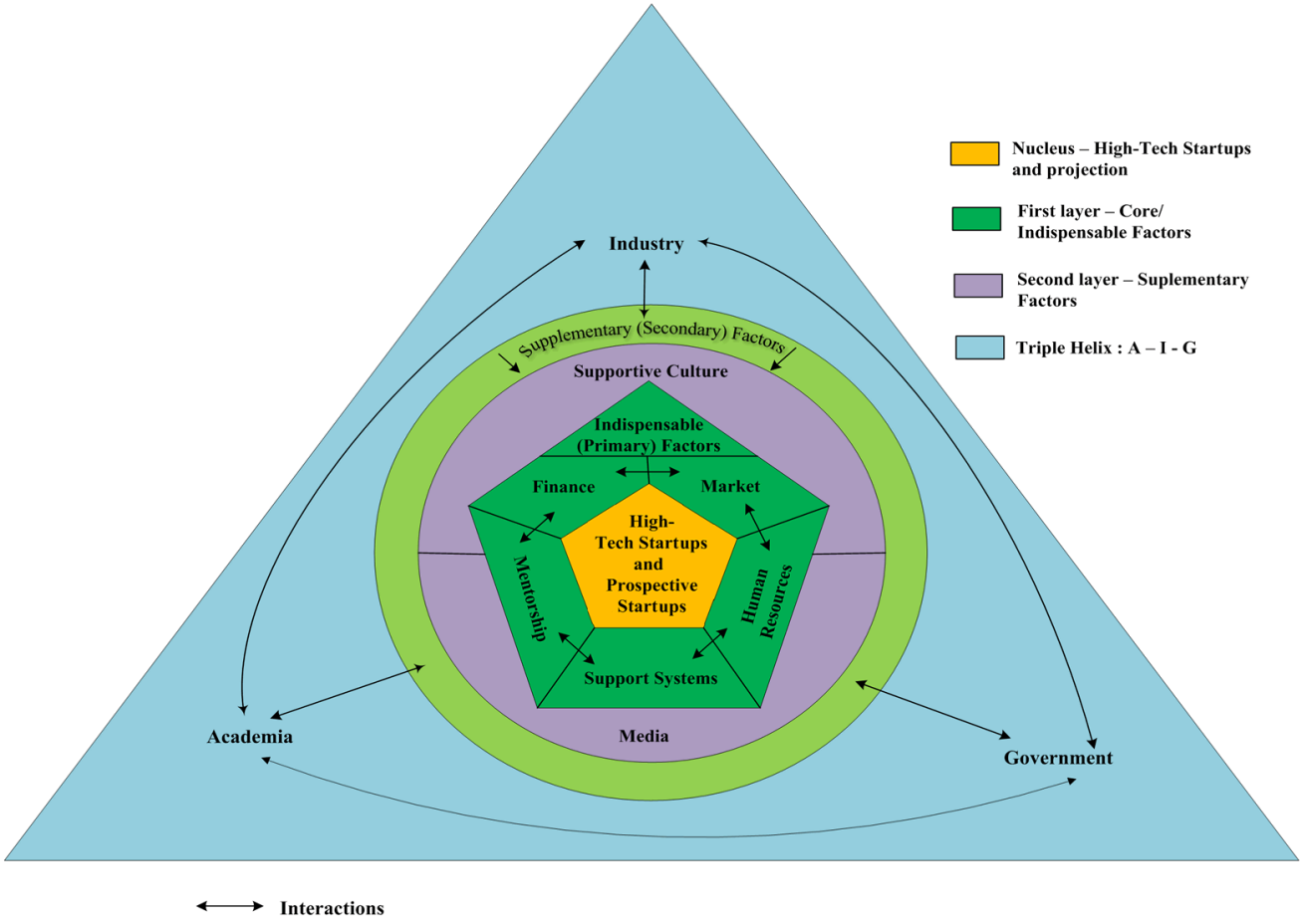

Figure 4. Hyderabad: Structure and components of the entrepreneurial ecosystem for technology startups in relation to the triple helix model

well as human resources for technology startups. The employees of large firms quit their jobs and enter the entrepreneurial world to implement their innovative ideas. Some of the multinational corporations explicitly encourage entrepreneurship among their employees by providing them sabbatical leave to experiment with their entrepreneurial ideas, with the option of returning to the company if the startup fails (ETB, 2016). Second, large firms provide early market support in the form of early adopters of startup products/services. Third, at times, they consciously nurture and promote startups through their own accelerators, with the objective of expanding market base for their own final products and services. Bangalore is home to many accelerators such as Kyron, Microsoft, SAP Labs, and Target. At a later stage, depending upon the "complementarity of business" and "compatibility of culture", they even acquire some of these startups.

India being a quasi-federal state, both the national government and the state government can play a direct or indirect role in the ecosystem for technology startups. The role of the national/regional government in startup promotion can be either passive or active. It can be passive if the government does not play any facilitating role. However, to begin with, immediately after independence, the national government located several key central public sector undertakings, public R&D institutions, and universities in Bangalore. In the meantime, the regional government created the much-needed industrial infrastructure (in the form of power, industrial area development, communication, water, etc.) and stimulated modern industrialization. This was followed by the growth of information technology and biotechnology industries, and multinational corporations setting up R&D centres, apart from facilitating the establishment of education and research institutes. All

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this led to an incessant inflow of talent from diverse corners of India.

Now, regional government appears to be an active facilitator of technology startups through the creation of support infrastructure such as venture capital funds and technology business incubators, though not on a considerable scale. But, the role of the government as an early adopter of startup products/services is hardly visible. More importantly, the Government of Karnataka (2015) has recently come out with an exclusive policy for startups to give them a further boost. It is the triple helix consisting of the academia–industry–government combination and its interactions which led to the gradual and steady emergence of a nucleus with a set of indispensable (primary) ecosystem components and supplementary (secondary) components.

The more than six decades' growth of Hyderabad, similar to Bangalore, saw the setting up of central public sector undertakings comprising a wide range of modern manufacturing industries such as machinery, electronics, and pharmaceuticals, coupled with the growth of much needed SMEs, educational institutions, and public R&D institutions. This was followed by the emergence and growth of information technology and biotechnology industries, and of late, by R&D affiliates of multinational corporations. This has resulted in the emergence and growth of triple helix model partners, namely, government, industry, and academia. All this has gradually and steadily led to the nurturing of different components of entrepreneurial ecosystem for technology startups. Hyderabad's current entrepreneurial ecosystem for technology startups is summarized in Figure 4. The ecosystem can be broadly viewed, similar to Bangalore, as a system within the triple helix model comprising: i) a nucleus comprising technology startups and prospective technology startups, surrounded by the existence of ii) indispensable (primary) factors (finance, market, human resources, support systems, and mentors), and iii) supplementary (secondary) factors involving supportive culture and media. The role of weather, unlike in Bangalore, is not explicitly visible in the context of Hyderabad.

Hyderabad is the home for several national-level education and research institutions, which play multiple roles in supporting and promoting the ecosystem. First, these institutions are the sources of entrepreneurship and human resources for technology startups. Second, these institutions provide mentorship and sometimes even facilitate market support for product testing as well as acting as early adopters of startup products/services. Third, some of these institutions (such as the International Crops Research Institute for the Semi-Arid Tropics, the International Institute of Information Technology Hyderabad, the University of Hyderabad, the IKP Knowledge Park, and the Birla Institute of Technology and Science Pilani) have their own technology business incubators and arrange for other support services including intellectual property consultancy, to nurture innovation and entrepreneurship through technology commercialization, particularly among their own faculty/would-be graduates. More recently, the Indian Institute of Technology Hyderabad (which was started in 2008) initiated its own technology business incubator.

Large firms, particularly multinational corporations, form another indispensable part of the ecosystem for various reasons. These include central public sector undertakings, domestic private firms, and multinational corporations. First, similar to Bangalore, they generate entrepreneurial talent as well as human resources for technology startups. The employees of large firms quit their jobs and enter the entrepreneurial world to implement their innovative ideas or they fund promising entrepreneurial ideas as angel investors. Second, large firms provide early market support in the form of early adopters of startup products/services that have business compatibility. Third, at a later stage, depending upon the "complementarity of business" and "compatibility of culture", they undertake mergers and acquisitions of some of these startups. Thus, large firms provide the much-needed direct and indirect support for technology startups such as entrepreneurship, market, finance and human resources.

Like in Bangalore, to begin with, immediately after the independence, the national government located several key central public sector undertakings, public R&D institutions, and universities in Hyderabad. During this time, the regional government was not visibly active in promoting industrialization. However, since the late 1990s, the state government has taken a pro-active stand for the promotion of information technology industries through the explicit development of specific infrastructure, while pharmaceutical and biotechnology industries have already registered their presence along with the growth of other manufacturing industries (Das, 2015). The process of setting up of R&D centres by multinational corporations began much later. Slowly and steadily, this led to an incessant inflow of talent, though not to the extent of Bangalore, from diverse corners of India.

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As of now, the regional government is an active facilitator of technology startups (much more than that of Bangalore) through the creation of support infrastructure. The setting-up of T-Hub (t-hub.co) in 2015, the largest technology business incubator in the country, represents just one example of the positive initiatives taken by the state government. T-Hub is designed for technology startups with the mission to catalyze the creation of one of the most vibrant entrepreneur communities in the world to encourage and fuel more startup success stories. It is a unique public–private partnership between the Government of Telangana and three premier institutes, namely, the International Institute of Information Technology Hyderabad (IIITH), the Indian School of Business (ISB), Hyderabad, and the National Academy of Legal Studies and Research (NALSAR) University, Hyderabad. It stands at the intersection of the startup, academic, corporate, research, and government sectors (T-Hub, 2016). The regional government has recently brought out an Innovation Policy and an Information & Communication Technology Policy, respectively which, among others, focused on the promotion of technology startups (Government of Telangana, 2016a; Government of Telangana, 2016b). Thus, similar to Bangalore, it is the triple helix consisting of academia–industry–government combination and its interactions that resulted in the gradual and steady growth of a nucleus with a set of indispensable (primary) ecosystem components and supplementary (secondary) components.

A summary of the similarities and the differences between Bangalore and Hyderabad, the two promising but evolving technology startups hubs of India, is presented in Table 4.

Table 4. Similarities and differences between the Bangalore and Hyderabad ecosystems

Similarities	Differences
The ecosystem foundation was laid after India's independence in 1947 for Bangalore and after the accession of Hyderabad to India in 1948 for Hyderabad. The public policies of the national government, supplemented by that of regional governments, subsequently played a key role in each ecosystem.	The period of emergence of the second phase as well as that of the third phase in Bangalore is distinctly different from that of Hyderabad.
Three distinct phases are ascertained in the evolution of entrepreneurial ecosystems for technology startups in both the cities.	The positive response of market forces to economic policy reforms played a major role in the early emergence of an information technology and biotechnology cluster followed by an R&D cluster in Bangalore, whereas pro-active regional government initiatives followed by market force responses played a major role in the subsequent emergence of the information technology and biotechnology cluster followed by an R&D cluster in Hyderabad.
The modern industrial cluster followed by the information technology and biotechnology cluster and then by the R&D centre cluster led to the gradual evolution of an ecosystem structure and its components.	Weather played a distinct positive role in the emergence of an entrepreneurial ecosystem in Bangalore, whereas weather has not played any explicit role in Hyderabad.
The structure and components of entrepreneurial ecosystems in both the cities are observed to be largely similar, but for the role of weather which stands apart in the context of Bangalore.	Bangalore accounts for the highest number of unicorn companies in the country whereas Hyderabad has none, at present.
Both the ecosystems are in the process of emerging and therefore in the "phase of evolving".	Bangalore accounts for a higher concentration of early stage startups and "cockroaches" relative to Hyderabad due to a higher level of vibrancy in the ecosystem. Accordingly, it is considered to be ahead of Hyderabad in the "quantity and quality" of ecosystem components and their interactions and therefore has a higher level of maturity relative to the latter.

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Conclusion

Entrepreneurial ecosystems for technology startups are unique and they do not emerge overnight. The emergence of such ecosystems takes place over a period of time. Among the economies across the world, India occupies a unique place as an emerging economy, accounting for the third highest concentration of technology startups and startup exits globally. In India, Bangalore has been attracting global attention increasingly, and more recently, as a hub of technology startups. Hyderabad, as one of the fast-emerging technology startup hubs in India, is closely following Bangalore. Given this, two questions are answered in this article: How did the entrepreneurial ecosystems of these two cities emerge over a period of time? and What is the structure of these ecosystems and what are their components?

The seeds for the emergence of the two ecosystems were sown immediately after India's independence in 1947 for Bangalore and after accession into Indian Union in 1948 for Hyderabad. Public policy driven central public sector undertakings, public R&D institutions, educational institutions, supplemented by domestic private enterprises led both the cities to emerge as modern industrial clusters. This was followed by the entry of multinational corporations in the information technology and biotechnology industries in response to economic liberalization (in Bangalore) and in response to regional government initiatives (in Hyderabad), which resulted in the emergence of information technology/biotechnology clusters. Subsequently, a steady liberalization of foreign investment rules and regulations encouraged a steady entry of R&D affiliates of multinational corporations in Bangalore, followed by in Hyderabad, which nurtured clusters of R&D centres. It is the successive addition of these three different but inter-related clusters that gradually and steadily led to the rise of various components of entrepreneurial ecosystems in the two cities with a strong base of government–industry–academia triple helix model.

Today, the entrepreneurial ecosystems of both Bangalore and Hyderabad have all the critical components that have been commonly identified in empirical literature in the international context. In addition, the diverse stakeholders of the two ecosystems enabled us to define the structure of an ecosystem in the Indian context. The triple helix model comprising government, industry, and academia formed the foundation of the ecosystem, within which the system involved a nucleus comprising technology startups and prospective technology startups with two outer layers. The first outer layer consisted of five primary (indispensable) factors (namely, finance, market, human resources, mentors, and support systems), whereas the outer-most layer comprised three secondary (supplementary) factors of culture, media and weather (in the case of Bangalore), culture and media (in the case of Hyderabad).

However, the ways the triple helix model operates in the two cities are different. Whereas in the Bangalore ecosystem, the triple helix interactions appear to have graduated from a "statist" model to a "laissez-faire" model and further to a "balanced" triple helix model, in the Hyderabad ecosystem, a "statist" model seems to be relevant even today. This is primarily because industry and academia have emerged, over a period of time, to be as important as the government, if not more, in Bangalore. But government continues to be the dominant partner in Hyderabad even today, due to its pro-active ecosystem promotional policies. This has been corroborated by our interviewed stakeholders in both the cities. But what does it imply?

Broadly, an ecosystem for startups is assumed to graduate through four different stages of evolution: i) nascent, ii) evolving, iii) mature, and iv) self-sustainable (Cukier et al., 2016). Considering that the vibrancy of both Bangalore and Hyderabad ecosystems is largely confined to a rapidly growing "emergence of technology startups", followed by a number of "stably operating" startups but with few "successful and grown" startups, it would be appropriate to conclude that these two ecosystems are still "evolving", and therefore, have only "moderately matured". Recently, in terms of the growth index for startup hubs, Bangalore has been ranked at the top internationally, followed by London and Tel Aviv (Velayanikal, 2015). The balanced triple helix model would prove beneficial to take Bangalore further towards maturity in the coming years. But the same cannot be assumed to happen in the case of Hyderabad. Only the continued active involvement of the government might ensure its further evolution towards maturity. In other words, any withdrawal or reduction in the role of the government might affect the further evolution of the Hyderabad ecosystem towards maturity.

Given the above, what are the key lessons/insights that we can derive from the experiences of Bangalore and Hyderabad for elsewhere in India and the world? The findings of our analysis yield three important lessons. First, the evolution of an entrepreneurial ecosystem in a technologically vibrant innovation cluster (Bangalore, which is often compared with a developed economy

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cluster) and an emerging innovation cluster (Hyderabad) within an emerging economy (India) is historically explored and analyzed. The critical factors that led to the laying of an ecosystem foundation gradually and steadily over a period of almost six decades in three different phases, along with other supportive factors are brought out. This finding clearly demonstrates that ecosystem development is an evolving process. But, this process will neither evolve naturally nor can it be built by design. As argued by Isenberg (2011), ecosystems are usually the result of intelligent evolution (a process that blends the invisible hand of markets and the deliberate helping hand of public policies).

Second, an entrepreneurial ecosystem is essentially regional in character. The present study has revealed the unique features and elements involved in the development of the Bangalore and Hyderabad ecosystems. An entrepreneurial ecosystem is unique as it is the result of multiple elements interacting in highly complex and idiosyncratic ways, as brought out by these two cases. Though the Bangalore and Hyderabad ecosystems have some similarities, they are not identical. This finding highlights that it is neither feasible nor desirable to replicate either Bangalore or Hyderabad, even within India. What is essential is to ascertain and understand the structure and critical components of an entrepreneurial ecosystem, without which an ecosystem might not emerge, even if it emerges it may not survive, and even if it survives it may not prove to be effective or successful.

Third, the structure and critical components of Bangalore and Hyderabad entrepreneurial ecosystems are ascertained. The triple helix comprising government, industry, and academia form the basis for an entrepreneurial ecosystem as it supports or generates the critical components of an entrepreneurial ecosystem. An entrepreneurial ecosystem for technology startups is defined as a structure with the triple helix as the base, and it comprises a nucleus (startup entrepreneurs and prospective entrepreneurs) with two outer layers consisting of some core and indispensable components as the first outer layer, which include: i) financiers (in the form of seed funds, angel investors, venture capitalists, and private equity firms), ii) markets, iii) human resources, iv) nurturers (in the form of accelerators, business incubators, and co-working spaces), and v) business and technology mentors. The second outer layer consists of supplementary factors such as supportive culture, effective media, and, if possible, good weather. Thus, the nucleus and the core components, supplemented adequately by the secondary factors, and with the triple helix as the base, define the structure of an ecosystem for technology startups. Their adequate and growing presence and interactions will generate vibrancy in the ecosystem for its further growth. This would lead to an increasing scale of technology startup emergence, nurturing for survival and stability, and growth of the successful ones, thereby contributing to national economic growth, innovation achievements, and employment generation.

Acknowledgements

This study forms a part of the research project titled "A Study on the Ecosystem for High-Technology Startups in Bangalore and Hyderabad", which is sponsored by the Department of Science and Technology (DST), Government of India, New Delhi. DST Project F.No. DST/NSTMIS/05/178/2014-15.

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Citation: Bala Subrahmanya, M. H. 2017. Comparing the Entrepreneurial Ecosystems for Technology Startups in Bangalore and Hyderabad, India. *Technology Innovation Management Review*, 7(7): 47–62. http://timreview.ca/article/1090

Keywords: startups, technology, ecosystems, entrepreneurship, Bangalore, Hyderabad, India

Q&A

Mohammad Saud Khan

Q. Are Universities Ready for Knowledge Commercialization?

A. Increasingly, the need for scientific knowledge in the innovation process is reshaping the role of universities from teaching and research to engines of knowledge commercialization. Being pressed for resources, universities are feeling a greater need to reach out to companies, which, in turn, helps these firms to acquire expert knowledge and advice without having to make in-house R&D investment (Svensson et al., 2012). Universities now face a direct role to participate in the economic development of their respective regions. Specifically, being seen as "entrepreneurial" (Guerrero et al., 2016) means that universities are now part of an evolving and complex engagement of multiple stakeholders (e.g., academics, corporations, universities) within the knowledge transfer ecosystem (Sengupta & Ray, 2017). Such a scenario has brought numerous opportunities (e.g., licensing, research contracts, consultancies, greater mobility with the industry) for academic institutions. Although universities have progressed in developing key internal processes to support knowledge transfer activities, the pressing issue revolves around the efficacy of connecting academic and corporate systems of knowledge. Moreover, to what degree are these new partnerships becoming a cradle of sustained innovation and entrepreneurship? This commentary focuses on a critical analysis of these challenges and how incubation support could address the journey of knowledge commercialization for universities.

Lack of Commercialization Expertise

The past decade has evolved a growing body of knowledge on wealth creation and exploitation of scientific knowledge in universities (Mascarenhas et al., 2017). Being awarded a patent is certainly a good indicator of a university's commercial endeavours, however, it is important to realize that this is only the initiation of implementing a business-relevant technology (Mets, 2015). The first major bottleneck encountered is the lack of commercialization expertise in universities. Founders of technology-based startups are quite often experienced specialists in their fields of technical and natural sciences but know little about business needs. This shortage of industry-specific knowledge puts university-based scientists in a situation where even the best of products often fail to penetrate the market. This handicaps the founder (during decision making) on issues related to equity capital of the startup or mergers and acquisitions, which can eventually result in sub-optimal, irrational, and unfavourable solutions.

The following case illustrates this scenario quite appropriately. AMET (Applied Mechatronic Engineering & Technologies) was an academic startup founded in Italy with a product portfolio encompassing hardware and software development (especially real-time control applications, design, modeling, and simulation). It comprised six team members: a PhD student, two professors, a recent graduate, and two researchers (Colombo & Piva, 2005). Although each member of the team was highly specialized in electrical engineering and possessed high educational background (mostly PhDs), they felt short on industry-specific work experience and entrepreneur-specific experiences. These competencies include knowledge and experience in analyzing competitors and customers, as well as organizational and managerial skills related to earlier self-employment in another environment.

AMET was at the initial phase of setting up the startup – a phase that often puts forth several challenges in terms of decision making. This case revolves around the discussions between team members in their evaluation of three possible financing options at this early stage. They had been approached by Altair Engineering, a large firm from the United States, with a proposal to collaborate and share equity. The second option under consideration was to join a new upcoming incubator, the Innovative Enterprise Incubator (I3P) at the Polytechnic University of Turin, Italy. The third option on the table was to leverage the infrastructure (equipment and machinery) of their parent organization, the Mechatronics Laboratory (Laboratorio Interdipartimentale di Meccatronica, LIM) housed at the Polytechnic University of Turin (the home university of the researchers). In these circumstances, the presence of a commercially oriented team member is vital for analyzing initial financial projections and feasibility,

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but university-based startups often lack such a team member, as did AMET. The six team members found themselves confused and were struggling to reach consensus. As Colombo and Piva (2005) aptly end their case: "Suddenly, the silence falls on the six entrepreneurs". Because these non-specialist team members (in terms of commercialization knowledge) contributed their judgments without a systematic process of financial projections and market analysis, only a haphazard exploration of the target market was undertaken by the founders. Preliminary projections in relation to revenue streams and market share (which were clearly lacking in AMET due to the absence of a commercially oriented team member) make a venture idea more tangible, motivating, energizing, and enthusiasm-driven for teams.

The above arguments highlight one of the first challenges as seen in terms of the depth and breadth of business and commercialization knowledge among founders of university-based startups. It is crucial to engage commercial expertise early in the process to fill up this kind of knowledge gap, which emerges at the introductory stage of a startup.

Dearth of Business-Oriented Ties

The second challenge in commercializing university research stems from the fact that "working ties to operating sectors of the economy are not central to the internal design of the university as an institution" (Lester, 2005). This challenge partially arises due to the fact that most academics typically have less frequent contacts with commercial entities and existing contacts are limited due to differences in work culture (Mosey & Wright, 2007).

The two most important requirements for a technology transfer include:

1. A university must be able to locate a buyer who finds value in the intellectual property and is also willing to investigate this intellectual property.

2. The buyer must gauge that the costs of licensing and patenting are lower than the value of this intellectual property.

University research is largely embryonic in nature with high technical and market uncertainty, making it difficult to manage investments at an early stage. However, external environmental conditions can sometimes facilitate a surge of funding for a particular scientific field. An interesting example is seen from the biotechnology industry, where the innovative potential is often linked to the novelty of the startup. Around 1997, an early stage biotechnology startup, UrGenT, was set up in Germany by five scientists (with no commercial expertise), focusing on genomics-based drug development (Cresey & Remer, 2004). UrGenT's initial aim was to undertake basic R&D on urogenital diseases, but they did not have a concrete product idea. Albeit, the startup was founded at the start of the biotechnology boom.

In spite of being a classic biotechnology startup, several experienced and high-profile venture capitalists were queuing to invest in UrGenT during the first round of funding in 1999, which facilitated remarkable early growth. Two years later, UrGenT entered a second round of financing only to experience a shift in market pulse, manifested by investor reluctance. The burst of the dot-com bubble had impacted the upward expectations in the biotechnology world as well. Although UrGenT succeeded in gaining investment and partnerships, it came with lower valuations (this time) and eventually an expectation to bring at least one retargeted drug into clinical testing within a short period. In doing so, UrGenT was forced to target short-term gain over long-term sustainability by ignoring additional pre-tests based on preliminary results only to fortify investor confidence. Unfortunately, the Phase 1 clinical trial failed, which left UrGenT in a financial situation in which the startup could last only a few months. This happens when firms are constantly struggling to secure investment opportunities and keep track of their milestones, which are often detracted by investors. Therefore, it is important to realize that the value in the embryonic work of a university startup is not necessarily the sole determinant of its success or failure. Therefore, it is vital for potential academic entrepreneurs to consistently transform and expand their business networks to develop and transfer their knowledge to business (Rasmussen et al., 2015).

Need for Greater Founder Dedication

The characteristics of a commercial setting demand dedicated individuals within the entrepreneurial team who have developed mutual trust through their relationships (Khan et al., 2015a; Khan et al., 2015b). This need is especially crucial in a university setting because corporate culture and business practices are already a new area for academics, who may need to face a tough terrain if the founding team lacks the consistent dedication required to handle it. The UrGenT case provides ample evidence in terms of the impact of a lack of founder devotion on the daily operations of a newly

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founded company. UrGenT was the brainchild of two biology professors who were well placed in their academic careers; the primary reason they wanted to start a new venture was that they had not founded a company as yet. They were unaware of any opportunities in the market and only wanted to take advantage of the government support programmes for the biotechnology sector. Furthermore, they were also not interested in running the company themselves and hired five additional scientists at a very early phase. The problem with such an approach is that the original founders not only lack a concrete idea and direction (to begin with) but also remained detached from the daily challenges faced by the company, which became evident through inapt group dynamics of the working team towards the end.

Managing Work Dynamics with Commercialization Partners

University knowledge commercialization often involves a large investing company. The governing factors binding this relationship may lead to certain challenges. The case of AMET illustrates these dynamics. Altair Engineering (the large engineering multinational) was keen to have an equity share in AMET. From a commercial standpoint, AMET, the young startup, could foresee the benefits of enhanced business development opportunities and the possibilities of extending their offer and potential market via this prospectively stable cooperation. On the other hand, Altair Engineering, being a larger player, posed the threat of opportunistic behaviour by creating appropriability hazards, technology spillovers, and an involvement in decision making within the younger partner, AMET. Subsequently, such alliance-formation scenarios have the potential of creating challenges for university–industry agreements in terms of conflict of interest and decision power issues. Similarly, another bone of contention is often the academics' need to publish, which may be at odds with the need to maintain confidentiality as far as corporations are concerned (Perkmann et al., 2013)

Balancing Technology Development and Business Development

The difficulty of valuing a university technology is significantly reduced when a startup is linked to a university (Rao & Mulloth, 2017). In the AMET example, the team members felt the need to stay close to the Mechatronics laboratory (LIM) that served as a parent organization for the scientists. This need is primarily secured to pull commercial benefits at an early stage of the startup and to gain advantage from technical competencies, human resources, and infrastructure. The flip side for a startup is the fear of being diverted from business development efforts and staying too focused on the academic aspects required for maintaining a privileged relationship with the university.

Investment Trials

One of the big tests for the university sector is the access and management of funding (Bellavitis et al., 2016). There are several reasons in support of the specific importance given to this challenge when compared to any other entrepreneurial venture. Such ventures mostly involve complex and fast-developing technologies that have long development periods. A large variety and large amounts of intangible assets come into play in the form of brilliant ideas accompanied with one or more patents to protect those ideas. In some cases, the assets may be either extremely specialized or there may be no tangible assets. This intangibility makes it difficult to attract traditional investors because they cannot evaluate the market value of the "soft assets" and recover their investments in case of failure.

As evident in the cases of AMET and UrGenT, the products were highly specialized (real-time control systems and urogenital disease drug identification). For AMET, the highly specialized mechatronics lab (LIM) was the available tangible asset. The biotechnology firm, UrGenT, went through several rounds of financing involving different types of investors at various stages. The challenge was to manage market entry in line with strict adherence to milestones for further funding. During their second round of financing, UrGenT deviated from their core competencies and adopted a new strategy by retargeting existing patented drugs for urogenital diseases. This new strategy was partly driven by the expectation that they could deliver faster (in terms of clinical trials of drugs) to their investors. Unfortunately, the struggle to reach the milestones and a lack of sound commercial knowledge led to vital strategic shifts that eventually brought failure. In essence, the inherent funding challenges for academic startups spiral into a bigger dilemma for managers of such firms, who may struggle to cope with appropriate financial investment and time schedules.

Incubation Support for Knowledge Commercialization

The role of an incubator in university knowledge commercialization should not be underestimated (Moeen & Agarwal, 2017). Another attention-grabbing case is

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CardioGenix, another biotechnology startup founded in Germany with very similar characteristics to UrGenT (Cresey & Remer, 2004) but that focused on developing drugs for cardiovascular conditions. Both startups began their journey through government funds and rolled out from the same incubator. The main advantages of the incubator for UrGenT were in terms of office space, initial seed investment, networking, and development of managerial skills through seminars. In comparison, CardioGenix saw similar benefits and received seed investment from the incubator, but the founders also looked for answers regarding their business model. They deliberated on two possible business models:

1. The first option would make the startup a traditional biotechnology firm making drug candidates and selling them to large pharmaceutical companies capable of large-scale testing and manufacturing. The founders could gain in the short run (through R&D), but long-term gains were not envisaged in this model (due to dependence on licensing to large pharmaceutical partners).

2. The second option was to develop customized drugs for patients, thereby making CardioGenix a comprehensive bio-pharmaceutical firm. This model faced challenges regarding technological feasibility, legal issues, regulatory approvals (to name a few), thereby necessitating greater financial resources and greater uncertainty.

Again, it was the incubator that helped CardioGenix shape its choice of business model (they choose the second option) by facilitating contacts with initial investors. Later in their financial journey, it was quite evident that the incubator strongly believed in the inherent potential of CardioGenix's innovative technology (drug research: customizable biochemical agents for a patient's genetic profile) and hence lept in to save it from imminent insolvency in 2001. The incubator not only provided bridge financing from their own funds but also arranged some funds from a German venture capital firm.

An added incubator-support perspective is the linking of an incubator to an ill-equipped capacity of a firm (as was the case with AMET) to help survive a competitive environment (in the long run) after exiting the incubator. The possibility of placing AMET as a virtually incubated company of the Polytechnic University of Turin within the Innovative Enterprise Incubator was also a possibility, provided the offer from Altair Engineering was also accepted. Consequently, the benefit of a relationship between a startup and an incubator is clearly significant in bringing university research to the market. However, great caution is needed when the support and assistance function of an incubator is pushed to the level of "creation from scratch" for revamping the business model.

Intellectual Property Protection and Shifting Market Trends

An important measure of technology transfer is the time between discovery and commercialization (Dutta & Hora, 2017). Accelerating the speed of commercialization delivers greater benefits to both the commercializing agent and the university in achieving quicker returns against R&D efforts. The role of timely intellectual property protection surfaces in this crucial period of discovery and commercialization. For university researchers that are relatively unknown, receiving a patent on the intellectual property seems to be a strategy that helps reduce uncertainty regarding the value (Elfenbein, 2005).

Even if a startup receives fast-track patent approval, it invariably loses valuable time because of the rapid shifts in market trends. This unresolved intellectual property issue ultimately leads to withdrawal of potential investors from negotiations. Indeed, time is of the essence, especially for the investors, because it is very risky to gamble on something for which the intellectual property is not protected. Furthermore, from an academic startup's perspective, something that may appear very promising today could be almost obsolete tomorrow based on several external factors.

Conclusion

So, are universities ready for knowledge commercialization? As the cases above illustrate, universities must overcome critical challenges when striving to make an invention become an innovation through the process of commercializing university research. It highlights the need for universities to consider a number of mechanisms collectively for designing policies that help in increasing commercialization of university research. And such efforts by no means devalue the importance of the main commercial mechanisms of licensing agreements: joint research ventures and university spin-offs (Siegel & Phan, 2005).

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Nevertheless, the complexities of these processes demand a strategic plan with a long-term view. Such a plan should perhaps incorporate inter-ministerial policy making for innovation, creation of a critical mass of diverse actors, efficient transfer channels, and interaction (Nilsson et al., 2006). However, at the same time, this industry experiences some peculiar challenges in terms of its very nature. These include requirements for large funds, complex and rapid technological development, stretched gestation periods, predominantly intangible assets, and high vulnerability to failure (Cresey & Remer, 2004). Thus, universities do recognize the need to commercialize knowledge; however, to be truly ready for knowledge commercialization, they must develop a shared commercial mentality with all actors within their broader ecosystem.

About the Author

Mohammad Saud Khan, PhD, is a Lecturer (Assistant Professor) in the area of Strategic Innovation and Entrepreneurship at Victoria University of Wellington, New Zealand. Before taking up this role, he was positioned as a Postdoctoral Researcher at the University of Southern Denmark. Having a background in Mechatronics (Robotics & Automation) Engineering, he has worked as a field engineer in the oil and gas industry with Schlumberger Oilfield Services in Bahrain, Saudi Arabia, and the United Kingdom. His current research interests include innovation management (especially the implications of big data and 3D printing), technology, and social media entrepreneurship.

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Citation: Khan, M. S. 2017. Q&A. Are Universities Ready for Knowledge Commercialization? *Technology Innovation Management Review*, 7(7): 63–68. http://timreview.ca/article/1091

Keywords: knowledge, commercialization, universities, research, technology transfer, entrepreneurship

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