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ICT Entrepreneurial Ecosystem for Engineering Education*

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Entrepreneurship is a powerful route to integrating skilled people into the working market. However, its teaching is particularly weak in engineering degree programmes. The objective of this innovative action has been to develop an entrepreneurial ecosystem to improve ICT entrepreneurial skills at engineering universities of countries with weaker entrepreneurial tradition in new technologies. An acceleration programme has been designed for engineering students with the objective of creating start-ups, going beyond the concept and becoming a start-up in early stage. Innovative methods have been applied to create and accelerate start-ups within an entrepreneurial ecosystem adapted to the university context. Four years of experience (2012–15) have allowed us to collect indicators and improving the proposed methods to scale up the model to the wider EU. Two hundred sixty-one students have participated in this experience and fifty-six start-ups have been created. Of those, thirty-eight have successfully finalized the programme.

Keywords: interdisciplinary projects; cooperative learning; engineering education; IoT

1. Introduction

Since 2008 Europe has been suffering the effects of the most severe economic crisis it has seen in 50 years. Many companies have been unable to survive for many reasons: a sustained drop in demand for their products and services, restrictions on credit and lack of payment for goods and services. In turn, this has led to an increase in the levels of unemployment, currently standing at over 23.9 million people, which has particularly affected young people. In February 2015, the youth unemployment rate was 21.1% in the EU28 and over 50% among Mediterranean countries (Spain, Italy and Greece), a situation considerably worse that the USA's jobless rate of 11.9% [1]. This has placed entrepreneurship at the heart of strategies for economic recovery in Europe and has been raised as a key factor in the context of the education of engineering students.

Numerous authors [2–5] highlight the interest of enhancing economic development and/or reducing unemployment in a region by means of: (1) facilitating the start-up of new companies, (2) increasing their survival rates and growth, (3) training entrepreneurs, and (4) stimulating firms involved in emerging technologies and in the commercialization of research done in engineering universities. According to the Kauffman Foundation report cited in the Entrepreneurship 2020 Strategy [6], new companies, especially start-ups, represent the most important source of new employment: they can create more than 4 million new jobs every year in Europe. Employment growth in the 21st century will come mainly from new ventures.

In this context, accelerator programmes are designed to significantly boost Internet startups' readiness for the market, using a mixture of mentorship and seed capital investment. This growing phenomenon started with Y-Combinator [7] (the first accelerator, which was founded by Paul Graham in 2005 in Cambridge, Massachusetts, and soon established in Silicon Valley). In 2007, David Cohen and Brad Fed, two start-up investors, founded TechStars in Boulder (Colorado) transforming their entrepreneurial ecosystem into an accelerator. According to Seed-DB, a platform which analyses seed accelerators and groups, currently accelerators are proliferating quickly worldwide with an estimated number of 215 accelerators, which have supported approximately 5,693 new ventures.

A comparison of 20 successful accelerators (see Table 1) was done from data available on Seed-DB platform, with the objective to know how the accelerators operate. The sample aroused from those programmes that are widely acknowledged as successful within the region where they operate. The selection of accelerators has been made to ensure that there is representation from Northern, Southern and Eastern Europe (9 accelerators), North America (5), Asia (4) and Globally established (2).

The vast majority of the compared accelerators follow the investor-model of Y-Combinator accelerator and have a generalist profile; they accept entrepreneurs whose business models are addressed to very different verticals sectors. This acceleration programme places a large focus on the mentorship element of the programme, where the quality of the programme is judged on the quality of the mentors

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Table 1. Comparison of 20 world relevant accelerators focused on start-up funding and own source of initial finance.

	Location	Website	Funding*	Equity	Source
SEEDCAMP	N. Europe	www.seedcamp.com	€75K	7%	VC
STARTUP BOOTCAMP	Global	www.startupbootcamp.org	€15K	8%	CORP
TECHSTARS	Global	www.techstars.com	€16K	6%	VC
TOP SEEDS LAB	S. Europe	www.topseedslab.com	€50K	15%	VC
OPENFUND	S. Europe	www.theopenfund.com	€50–500K	10%	EU, VC
NDCR LAUNCHPAD	N. Europe	www.ndrc.ie	€20K	8%	UNI
STARTUP42	N. Europe	www.startup42.org	€ 0	0%	UNI
WAYRA	Europe, S. America	www.wayra.co	€50K	10%	CORP
STARTUP YARD	E. Europe	www.starupyard.com	€30K	10%	VC
ELEVEN	E. Europe	www.11.me	€25K	8%	EU
STARTUP WISE GUYS	E. Europe	www.startupwiseguys.com	€40K	8%	EU
Y COMBINATOR	N. America	www.ycombinator.com	€106K	7%	VC
LAUNCHPAD LA	N. America	www.launchpad.la	€44K	6%	VC
ALPHA LAB	N. America	www.alphalab.org	€22K	5%	VC
ANGELPAD	N. America	www.angelpad.org	€18K	7%	VC
SURGE ACCELERATOR	N. America	www.surgeventures.com	€27K	8%	CORP, VC
JFDI	Asia	www.jfdi.asia	€16K	20%	VC
SPARK LABS	Asia	www.sparklabs.co.kr	€22K	6%	VC
THE STARTUP CENTRE	Asia	www.thestartupcentre.com	€18K	6%	VC
INNOVYZ	Asia	www.innovyz.com	€13K	8%	CORP, PUB, VC

* Figures converted from original currency and rounded to the nearest thousand.

that it attracts creating a virtuous circle where better mentors attract better start-ups, which in turn attracts better mentors. The more established programmes (e.g. Y-Combinator, Techstars, Bootcamp) also, as an extension, heavily promote their existing alumni network as another source of mentoring and extending your business network. An exception to this is Startup42 whose main focus is on offering space to work and access to the knowledgeable network of the attached university.

All of the accelerators listed offer workspace to the start-up companies. In some of the accelerators this is an optional service while in others such as Techstars, it is compulsory to work within the shared space offered in order to cultivate a peer network to provide solutions and support throughout the programme period.

Commonly access to services, otherwise known as 'Perks', are offered to start-up companies as part of the accelerator's marketing for the programme. These 'Perks' take the form of hosting, office software and business tools that come in various forms as free, trial periods or heavily discounted. Less commonly but still prevalent is the offering of professional services in consulting, legal and accountancy. These services are either offered as free (e.g. Innovyz, Y-Combinator), discounted (e.g. Seedcamp) or deferred billing (e.g. JFDI). Some of the less common services provided include: professional blogger and code reviewer (Startup Yard); international pitching trips (Eleven and Seedcamp); and dedicated pitching coach (NDCR).

In summary, accelerator programmes have grown in popularity over the past ten years, following the success of schemes like Y-Combinator and TechStars in USA. Initially many of them were generalists but now they are directed at a variety of industrial sectors (energy, health, IoT, automotion, etc.). There is now a growing number of established accelerator 'brands' operating multiple programmes across the six continents, however only a reduced number of universities have developed entrepreneurial ecosystems / accelerators for start-ups beyond the traditional incubators. In this sense, there is a long way to go.

In this article we propose an entrepreneurial ecosystem and acceleration programme for: (1) improving the entrepreneurial skills of our engineering students and (2) fostering the creation of ICT technological start-ups oriented to businesses for the app economy and the Internet of Things (IoT) technologies. This ecosystem and some innovative methods have been tested since 2012 in a public and technological university in Spain with the aim to stimulate the start-up ecosystem in a region of southern Europe with limited industrial structure on ICT and one of the highest rates of youth unemployment in Europe. The acquired experience and lessons learned are transferable to other universities.

The paper is structured as follows: section 2 presents the preliminary studies carried out to understand the ICT entrepreneurial environment in European universities and particularly in engineering institutions. After this, we present the objectives and ambitions for the current research work highlighting the innovative aspects. Section 3 presents the implementation of the proposed university entrepreneurial ecosystem and services provided. The core of this ecosystem is an eight-month

Incubation / Acceleration programme, which is described more fully in section 4. Section 5 discusses the results obtained in the last four periods (2012–2015) and finally, in section 6 the main conclusions and future works are presented.

2. Initial studies, vision and objectives

The need for curricula that educate engineering students about market forces and other business concepts has been discussed widely [8–11]. Entrepreneurship education, business incubators and accelerators are tools to promote the creation of successful entrepreneurial companies in many countries of US and northern Europe. In 2005, Kuratko exhibits the emergence of entrepreneurship education [12]. However, ICT entrepreneurship in Europe lags behind the US, in terms of effectiveness, scale and impact. In 2010, we carried out a preliminary study to investigate the landscape of entrepreneurship education in the universities of the European Union, and particularly in the countries of eastern and southern Europe because they were the most affected by the financial crisis and they were therefore in a situation very similar to our socio-economic conditions.

The search for information was conducted primarily on the Internet, reports prepared by the European Commission about entrepreneurship [13], working papers from conferences and downloaded articles. This enabled us to identify the main innovative programmes and universities in engineering entrepreneurship. After this, we collected detailed information from the websites within the universities detected in the 27 Member States of the European Union in 2010 and quantified the situation of seven relevant indicators (see Fig. 1) using a score from 1 to 10. It was necessary to reduce the sample of EU universities under study due to their characteristics varying widely from one country to another. For this reason, only public and technological universities were considered and they were grouped into four categories: Northern Europe (44 universities from Denmark, Finland and Sweden), Central Europe (331 universities from Austria, Belgium, Germany, Ireland, Luxemburg, Netherlands and UK), Southern Europe (251 universities from Cyprus, France, Greece, Malta, Italy, Portugal and Spain) and Eastern Europe (239 universities from Bulgaria, Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

Our study revealed that entrepreneurship education in universities was a recent multi-layered phenomenon in the European Union that was growing rapidly taking into account the number entrepreneurial activities arising at universities (undergraduate and postgraduate courses, PhD programmes, courses of specialization, extra-curricular activities, university incubators, etc.). The situation was very unequal across the EU countries due to different reasons: (1) not all countries have the same size and population, and (2) higher education systems and models are different in spite of the Bologna Process. The obtained data confirmed some assumed hypothesis: the teaching of entrepreneurship was particularly weak in the Member States that joined the EU in and after 2004 (Eastern EU) and there was a clear difference among northern countries and the other EU member states.

Another important aspect detected by the above study was the majority of entrepreneurship courses

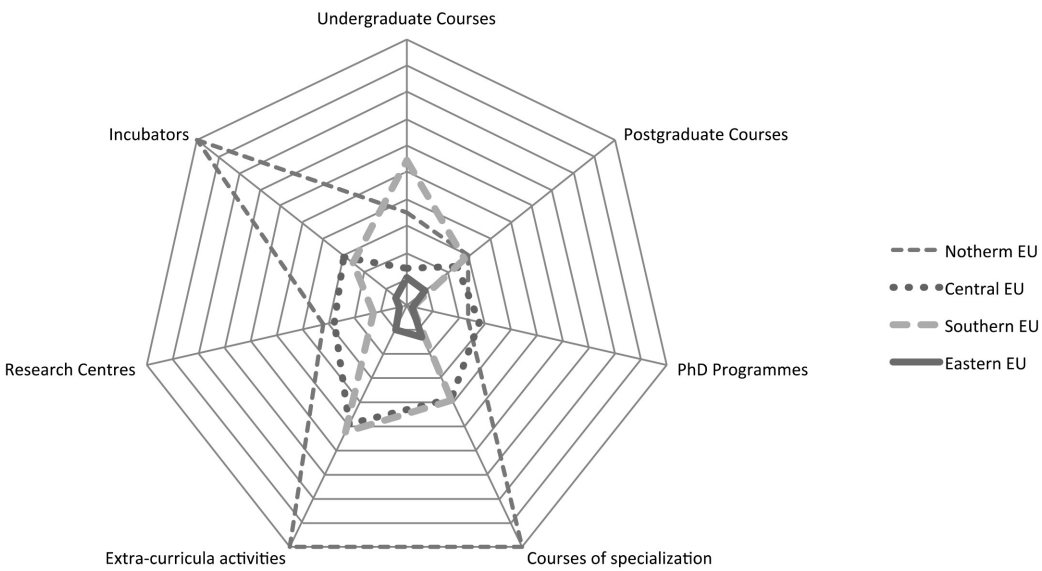

Fig. 1. State of Entrepreneurship in the EU27 using a score from 1 to 10 for seven relevant indicators (2010).

were offered in business studies and not in technological and engineering studies. We found the appropriateness of this circumstance highly questionable because disruptive ideas that lead to scalable innovative business models tend to arise in technological, scientific and creative environments. Similarly, the ever increasing rate of technological evolution puts engineers in an advantageous position for starting a venture because of their access to potentially disruptive technology and their ability to more completely understand its true potential and how the possibilities surrounding deployment.

The results obtained in the above study have not varied after four years, however there are recent signs that the situation will change very soon. The economic imperative of searching for new avenues for growth and future competitiveness led the European Commission to announce funding for some innovative actions under the Horizon 2020 research programme [6]. These actions include the promotion of international summer academies, acceleration programmes and entrepreneurial ecosystems as part of a broader policy brief, work commenced on promoting the Start-up Europe initiative in February of 2014 [13]. These initiatives, which post date the work described in this article, have provided an opportunity to further develop our own programmes, which are currently benefiting from being part of the Start-up Europe movement.

In this European context, the present innovative action is emerging as an ambitious initiative (known as Cloud Incubator HUB) that proposes methodologies to be carried out within engineering education institutions that are created from inception with a pan-European scope. At the heart of our proposal is the development of an entrepreneurial ecosystem within the university, rather than the delivery of postgraduate and undergraduate courses within student curricula. There are many business programmes that include training in entrepreneurship but do not offer the necessary technological training. Equally, it is uncommon for technological masters degrees to include training in business issues. Täks shows that integrating entrepreneurship studies in an engineering degree programme can be experienced in a variety of ways by students [14]: (1) a first step to self-directed learning, (2) a preparation for work life, (3) a path to possible self-employment, and (4) a context for developing leadership and responsibility for team achievement. Clearly, these skills facilitate the attitude toward entrepreneurship and numerous authors have analysed data related to engineering student interest and involvement in entrepreneurship education and the characteristics of students who participate in entrepreneurship courses or programmes [15]. Thus, Jamison outlines different aspects to be considered in the process of transforming engineering education by introducing the term hybrid learning [16]. However, in Europe, the complexity and density of engineering studies tends to make the inclusion of new subjects in the curricula difficult. Consequently, we have found that the development of an entrepreneurial ecosystem in the University provides a more flexible framework for nurturing entrepreneurship and has many advantages for the students: (1) the acquisition of knowledge fits better with the different student profiles (2) the students develop complementary skills through extracurricular activities, (3) they share knowledge and experience with others students with different background, (4) professionals from outside the university can mentor students and pass on valuable business know-how and (5) the students can become part of the broader ecosystem from the last courses of their studies, bringing forward their contact with a real, functioning business environment.

In order to build this ecosystem, a triple helix model [17] was followed. This model develops trilateral relations: (1) central and regional governments supported politically and economically the ecosystem from their conception and EU structural funds financed this initiative; (2) the university provided researchers who have transferred their knowledge to the start-ups and provided training on business and ICT topics; and (3) private investor groups (venture capital and angels) linked very early to the initiative in order to contribute knowledge and resources. All these aspects are summarised on Fig. 2.

3. University entrepreneurial ecosystem

The above considerations led to the launch and development of the Cloud Incubator HUB (henceforth, the HUB), an entrepreneurial ecosystem whose main goal is to encourage tech start-ups in the field of ICT. In particular, the HUB provides an inspiring environment where engineering students can satisfy the ambition to start a successful business and/or extend their existing business in one area of great attractiveness, such as mobile technologies and IoT. According to Bergek's categories [18], a HUB is a framework with a high level of technology, where cooperative initiatives and networking, in a wide range of topics among engineering students, mentors, coachers, investors, researchers and experts are promoted.

These actors are the key of the entrepreneurial ecosystem and participate in the incubation/acceleration programme that provides a suite of services (see Fig. 3) for overcome the existing barriers [19] in the process of starting up a firm. These services include: physical space and technological facilities

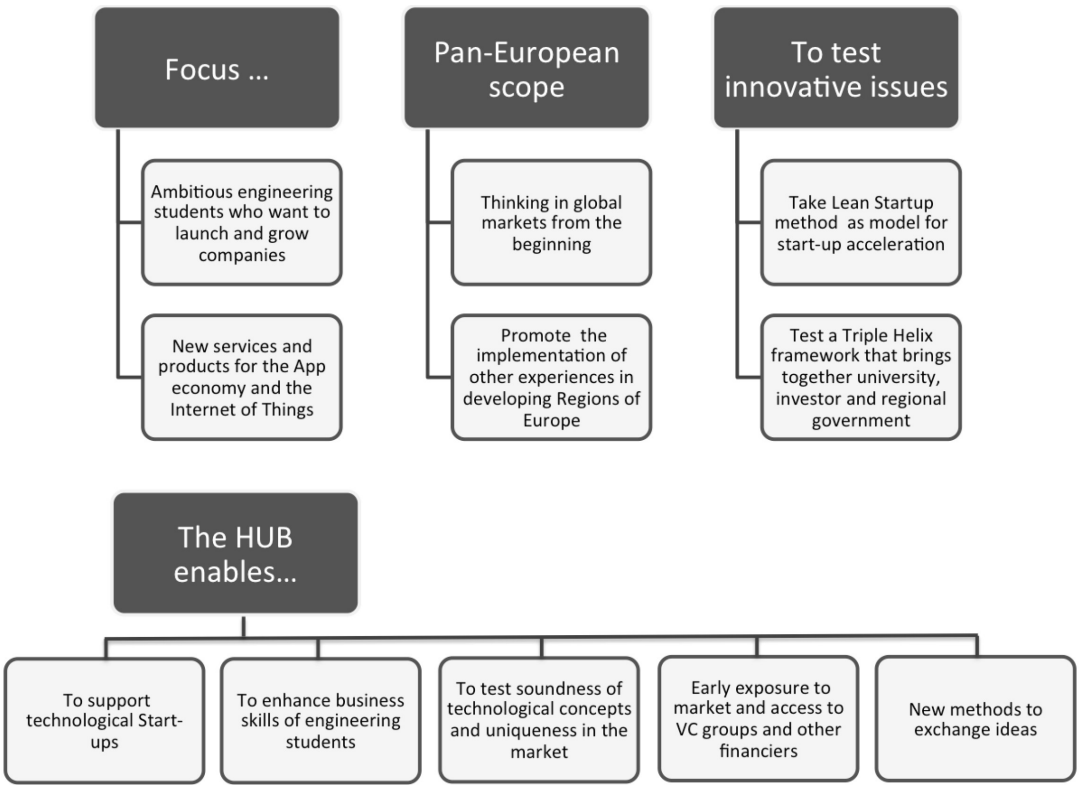

Fig. 2. Summary of the main aspects of Cloud Incubator HUB: Focus, scope and approach.

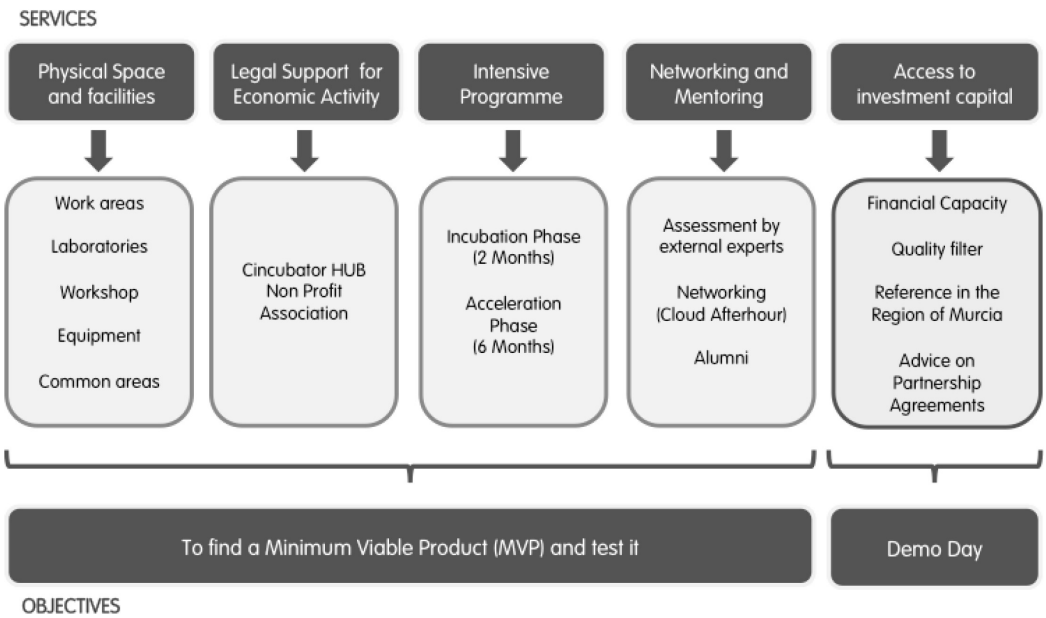

Fig. 3. Cloud Incubator HUB Services: physical space and technological facilities in a technology park, legal support for economic activity, intensive programme of acceleration, coaching networking and mentoring and access to investment capital.

in a technology park, legal support for starting economic activity, intensive programme of acceleration, business and technological training, mentoring, coaching networking, access to successful entrepreneurs as mentors (alumni) and access to investment capital, amongst others.

Given that the HUB is organised on a cross-disciplinary basis, the engineering students are provided with a range of services as wide as possible. Thus, students stay in touch with professionals and researchers, not only in various different branches of engineering, but also in non-technological dis-

ciplines (law, business sciences, consulting and communication). All these disciplines being offered together make it possible to provide students some comprehensive and efficacious services. All these services are described as follows (the incubation/acceleration programme is explained in section 4):

3.1 Physical space and technological facilities

The HUB is physically located at Fuente Álamo Technology Park, a place situated in the southeast of the Region of Murcia (pop. 1,500,000) where the Technical University of Cartagena has a building dedicated to technological development and innovation. As stated before, one of the goals of the HUB is the incubation/acceleration of start-ups related to IoT and Mobile Services. To this end, the HUB has: (1) four fully equipped work areas with MACs, PCs, tablets, smartphones and digital blackboards; (2) a laboratory for the design, prototyping, manufacturing and testing of consumer electronic of devices (e.g. gadgets for smartphones); (3) a workshop for the development of smart vehicle applications equipped with two electrical vehicles and tools; (4) a laboratory for the manufacturing of 3D prototypes; (5) a private road where smart vehicles can be tested and (6) a wireless sensor network of 60 complex nodes deployed in the Fuente Álamo Technology Park for the development and testing of applications in many fields (precision agriculture, industrial facilities, etc.). The technological infrastructure on offer greatly reinforces the ability of the HUB to attract engineering and other talent and stimulate the development of a wide variety of technological solutions that span industries from Agrofood to Smart Cities and Intelligent Vehicles. In addition, the HUB offers all the other services provided by the Technical University of Cartagena: conference and meeting rooms, classrooms for training courses, rest areas, kitchen and dining room. In total, more than 2,000 square meters for the incubation/acceleration of technology projects.

3.2 Legal support for starting economic activity

One of the first decisions of the start-ups is selecting the right time to be constituted as a legal entity. An early constitution involves the disbursement of money that could be invested on more productive activities. Not being prepared legally can be problem in terms of pursuing business opportunities. In any case, the constitution of the start-up, as a legal entity, is a necessary precondition to billing and generating income, and testing initial commercial feasibility. To address this, the HUB founded a non-profit association for which students and start-ups can apply for membership. With this legal instrument, start-ups can bill the activities that they carry out from day one. The income is credited to Association, and when the start-up is ready (usually after initial feasibility has been proven) the formal process of constitution can begin and any contracts and IPR are transferred from the association to the newly-formed company.

3.3 Networking, social networks and mentoring

The HUB recognises the importance of networking for students to establish a professional contact base for future business development. To do this, different resources are offered both off-line and on-line. On the last Thursday of each month, the Cloud Incubator Afterhours are organised. It has become the best-known space for networking, entrepreneurship and research on ICT in the Region. It plays a recognised role as a forum to exchange knowledge and stimulate co-creation. The knowledge base is provided by experts in various disciplines that explore entrepreneurship in ICT from different perspectives, and co-creation is the result of the connection of ideas and networking (both key elements for the Cloud Incubator Afterhours). Mentors, successful entrepreneurs, investors, local authorities and students are the main participants in these conferences. The aim is to proactively present this initiative to society and promote the culture of entrepreneurship.

The HUB is also active on the most common social networks: Twitter, LinkedIn, Facebook, F6S and YouTube. By accessing them, entrepreneurs can transmit their personal branding information, ideas and business opportunities. The HUB also has appointed a Community Manager that is responsible for disseminating the activities in spoken and written media, and a mailing list to disseminate interesting news among ecosystem members.

The mentors' role is decisive in helping start-ups to mature. They are professionals equipped with the necessary experience and knowledge to help entrepreneurs clear up any doubts about their start-ups and find the right path to success in their projects. Mentors are experts in the technological and business fields necessary to start up a technology-based business. A number of them are also entrepreneurs who have founded and grown successful enterprises.

3.4 Access to investment capital

One of the problems faced by start-ups in the current economic climate is the immense difficulty in obtaining the finance necessary to develop ideas and projects from banks, VC firms, investment funds and other sources of seed capital. Our investor network is constantly evolving and is open to any investor, financier or business angel who could be interested in the initiative to foster start-ups with

innovative projects that are competitive in the present technological market. Because of this, the HUB maintains a network of investors that includes business angels and VC groups. The HUB, through an investor group, supports high-tech start-up companies as they near commercial viability by providing access to early-stage capital, accelerating company development. These funds are designed to support this critical stage in the development lifecycle to prepare companies for follow-on private investment. Companies developing technologies in mobile technologies are eligible for these funds through the HUB. The Pre-Seed fund loan is up to €60,000. Eligible start-ups must have successfully completed the concept development and initial market feasibility stage, have revenues under €1 million and under €1 million in third party funding. To date, the start-ups have obtained €600.000 in funding from these local sources.

4. Incubation and acceleration programme

The core of the proposed ecosystem consists an eight-month incubation/acceleration programme. During this period, the students of the HUB work together with other ecosystem members to build their start-ups taking them from the concept to the early stage.

The precise approach depends on the degree of maturity of a given start-up, which are classified as concept start-ups, early start-ups and growth start-ups. The differences between the latter two are shown in Table 2. Start-ups from universities most commonly fall into the concept and early start-up categories. Only a few of these become growth start-ups. The incubation phase is focused on the creation of concept start-ups, while the acceleration phase is focused on ensuring their progression to early start-up.

The programme involves business and technological topics that provide skills for developing and accelerating the start-ups' growth. Each edition of the programme includes a two-month incubation phase and a six months acceleration phase. Fig. 4 and following sections summarises these two periods. The first step is dedicated to launching the calls for participation in the HUB incubation/acceleration programme. The open calls are published in May every year, targeted to either students in their final year who intend to launch or have already launched new start-ups in the field of mobile and IoT technologies. The number of participants in each incubation/acceleration programme call is typically 50 students per call. They initially compete for the 12 available places for start-ups in the HUB incubation/acceleration phase. The HUB organises tutorials, training events and hackathons with the aim of raising awareness, publicising the initiative and even providing some initial training in order to stimulate the presentation of proposals. Calls are widely published using the channels of the University and HUB for public calls and have clear standards with respect to evaluation, dealing with conflicts of interest and confidentially.

4.1 The incubation phase

The incubation phase for concept start-ups, which takes two months, begins with an intensive kick-off week. The objective of this phase is to create new start-ups. This initial training guides the students during the subsequent months. It serves (1) to explain the objectives and planning of the acceleration programme; (2) to train start-ups on business models and the Lean Start-up methodology and how to sketch out the business model and test it; (3) to disseminate technological trends in mobile technologies that entrepreneurs are able to introduce into their products, and (4) to establish communication channels and relationships with peers, mentors, investors and the staff of the acceleration programme. During this week, students are able to learn from the experiences and best practices from others. Each concept start-up is prepared in close interaction with the staff of the HUB. This enables the students to receive feedback on their ideas. This

Table 2. Classification and characteristics of start-ups depending of the degree of maturity

Start-ups in concept stage	Start-ups in early stage	Start-ups in growth stage
Earliest stage of start-up/formation stage	Alpha/beta product	Market ready product developed
Addressing basic value proposition	Researching market and potential opportunity	Significant levels of funding raised
Beta project in development	Refining the business model	Strong levels of customer validation
No revenue	Some traction	Experienced team that is expanding
Often a sole founder	Little or no revenue	Team is quickly growing
No product or service	Growing team	Business has initial revenue of at least €1 million
No customers		
Need to establish a business model		

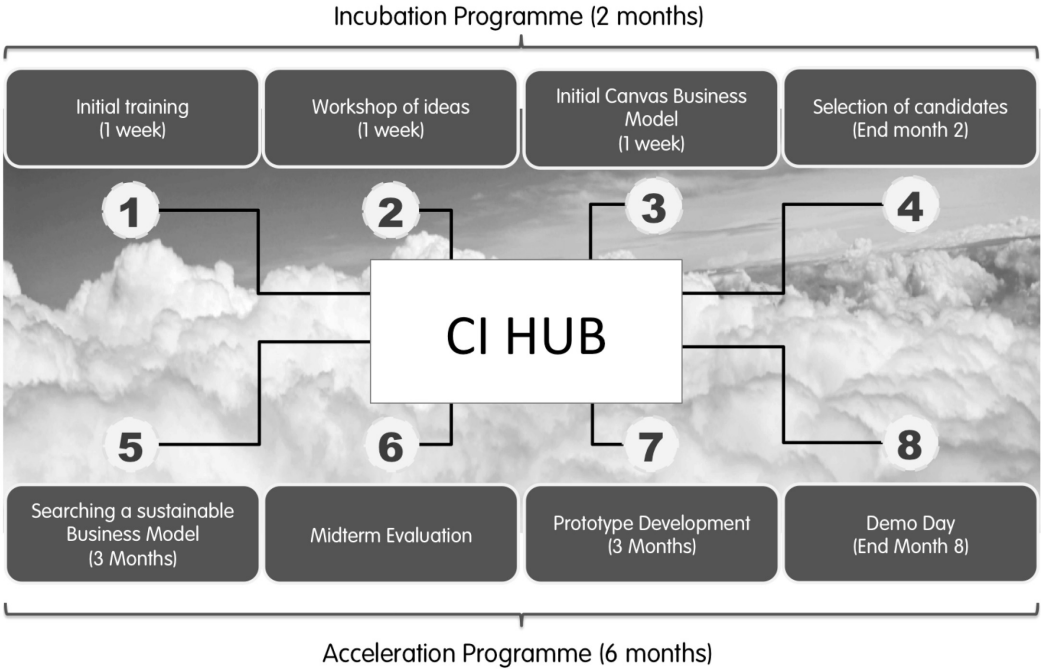

Fig. 4. Cloud Incubator HUB programme: an eight-month incubation/acceleration programme.

experience is aimed at promoting the active participation, co-working networking and continuous interaction of entrepreneurs.

In the second week a Workshop of Ideas is organised where students can explain their ideas and initial business models. Following this workshop, students summarise their hypotheses in a business model canvas. This chart allows each student to sketch a one-page business model with nine building blocks [20]. Each component of the business model contains hypotheses that will be tested. From these canvas business models and the discussions with the students in the previous stages, the staff members carry out the Selection of Candidates. Staff members also evaluate the proper balance of technical and non-technical backgrounds in the teams, so the teams are truly multidisciplinary, and the members bring a wide variety of experiences and expertise. Once the candidates have overcome the concept phase, they have six months to successfully accelerate their start-ups to the early stage.

4.2 The acceleration phase

The number of participants in the acceleration phase is usually around 12 start-ups per call (24–36 entrepreneurs). The first part of this phase consists of a 3-month period (see Fig. 4). In this first stage all participants work on searching a sustainable business model and deepening on their product concept following the Lean Start-up methodology. It makes the process of starting less risky. Weak points can be detected early enough to avoid potential financial losses and ultimately improve the success rate of new ventures. The methodology is based on the following three key principles [21]:

4.2.1 Sketch out hypotheses

The aim is to build a business model canvas [22] from a set of hypotheses in the basis of the current market knowledge. The canvas business plan is a visual chart of how a company creates value for itself and its customers. It includes in single page the nine areas that are critical to consider when designing a business model (value propositions, customer segments, customer relationships, channels, key partners, key activities, key resources, cost structure and revenue streams). This template helps entrepreneurs to map, test, and iterate their business ideas very fast.

4.2.2 Listen to customers

The second principle is focused on testing the hypotheses that contain each block of the canvas model. For this, the Steven Blank's customer development methodology is used [23]. Applying this methodology, start-ups try to find business plans that work. Thus, a minimum viable product [24] is deployed to a subset of possible customers, as early adopters, with the objective of testing the market, measuring take-up and obtaining feedback about product price, distribution channels, product desirability, etc. From this customer input it is possible to refine the initial hypotheses and start the cycle again, or pivot to new hypotheses. Once the business model has been successfully tested over a few weeks or months, the implementation phase begins, focus-

ing on building and testing a prototype ready to sell, building demand and finally building a formal enterprise with departments executing the business model. All these stages are iterative and can fail several times before the right approach is found.

4.2.3 Quick and responsive development

The third principle of Lean Start-Up methodology is *agile development* [25], also used in the modern software engineering and commercial software development. It is based on iterative and incremental development, which eliminates wasted time and resources by developing the product iteratively and incrementally. It is the process by which start-ups create the minimum viable products containing only risky features. Once they get feedback on it from customers, the process starts again with a revised minimum viable product.

Following this methodology, projects are developed in close interaction with members of the HUB entrepreneurship ecosystem, so that participants receive feedback from them. During these 3 months they should obtain a sustainable business model and should be able to demonstrate the commercial viability of the proposed business models. Halfway through the acceleration phase a Midterm Evaluation of partial results is made in order to: (1) evaluate if they have reached a sustainable business model and (2) evaluate if its minimum viable product has been refined enough to sell through actual sales. Start-ups that do not successfully pass this stage leave the programme. This process is undertaken again at the HUB facilities where all the students meet once more.

In the second part of the acceleration phase (3-months), the students develop their prototypes following the agile development methodology. This phase is also used to work on their businesses in much greater detail (including business plan, market plan, action plan, among others), adapting initial approaches to market requirements, and focusing more on revenue generation. At this stage, legal and commercial aspects will also be developed further.

Once the acceleration programme has been completed, entrepreneurs meet in a roundtable Demo-Day where they show their products to investors and to the HUB ecosystem. Poor to this, many investors will have been interacting with entrepreneurs from the very beginning by means of the crowd-promoting platform. The event must be dedicated to showcasing the teams and allowing them to get feedback so they can strengthen their business offering. In general, the event is planned as a place for service providers, supporters, prior and new investors, mentors, and other interested parties understand the milestone that entrepreneurs have achieved and the next steps on their venture.

5. Discussion

The specific challenge of the HUB initiative has been "to create an environment in the Technical University of Cartagena that encourages more Web entrepreneurs to launch a business and grow globally". The focus has been on "Web entrepreneurs who use Web and mobile technologies as main components in their innovation on topics related to IoT". To achieve this challenge, an entrepreneurship ecosystem has been set up and linked through social networks and an online platform upon the knowledge, experience, relationships, tools and existing open source software provided by professors, technicians, students and entrepreneurs of the Technical University of Cartagena. From this initiative has been obtained the following results that we discuss below.

5.1 A new innovative and entrepreneurship environment

Rothaermel and Thursby mentioned the benefits of a balanced approach combination of the necessary university link for some start-ups with professional managers in order to reduce the incubator firm failure [26]. The HUB ecosystem goes beyond existing Business Innovation Centres (BIC, i.e. CEEIC and CEEIM) in the Region of Murcia. These centres only provide: (1) shared office spaces, (2) a pool of shared support services to reduce overhead costs and (3) professional legal and business support. The synergistic collaboration between these innovation centres and the HUB ecosystem has led to mutual benefits. The latter has provided growth start-ups to the BICs after finishing the acceleration programme while the BICs' professionals has been involved in the programme as coachers and mentors. Moreover, the technological nature of the University has enabled the participation of researchers with wide experience in many ICT fields (such as, communications engineering, software engineering and electronic engineering). It has promoted the development of fast growth products and the participation of students as well as graduates. The result has been a new innovative environment inside the Technical University of Cartagena including services that helps students in their process of creating their start-ups. Table 3 shows the evolution in the composition of the HUB ecosystem along the first four years of the initiative.

As shown above, the initiative began with a very small group of people (staff and researchers), most of them university professors with engineering skills and business experience as entrepreneurs. From the

Table 3. Evolution of main indicators in the composition of the Cloud incubator hub ecosystem along the first four years of the initiative

	Results			
Members of the CI HUB Ecosystem	**1st Edition Jan. 12–Aug. 12**	**2nd Edition Sep. 12–Apr. 13**	**3rd Edition Sep. 13–Apr. 14**	**4th Edition Sep. 14–Apr. 15**
Total number of entrepreneurs at the beginning of incubation programme	72	60	62	67
Total number of start-ups at the beginning of acceleration programme (entrepreneurs in brackets)	18 (55)	13 (33)	12 (27)	13 (39)
Total number of start-ups that finish acceleration programme (entrepreneurs in brackets)	10 (32)	9 (19)	10 (18)	9 (25)
Staff with full / part time dedication	2 / 1	2 / 2	2 / 4	2 / 8
Mentors/ Coachers / Researchers	3 / 4 / 3	3 / 7 / 6	5 / 10 / 6	7 / 10 / 10
Business Angels / Venture Capital groups	1 / 0	2 / 1	4 / 2	4 / 2
Other incubators and BICs	1	2	2	2
Alumni	0	32	51	69
Funding	€120.000	€130.000	€170.000	€180.000
Employment	32	19	18	25

Table 4. Evolution of the social media indicators collected along the first four years of the initiative

	Results			
Social media indicator (SMI)	**1st Edition Jan. 12–Aug. 12**	**2nd Edition Sep. 12–Apr. 13**	**3rd Edition Sep. 13–Apr. 14**	**4th Edition Sep. 14–Apr. 15**
Total number of visits http://cincubator.com/	12,236	25,255	20,086	30,113
Page Rank http://cincubator.com/ at the beginning/ at the end	1 / 2	3 / 5	6 / 6	6/6
Total number of posts in the Blog of CI Hub	14	28	20	32
Total number of members in the CI Hub mailing list	102	200	280	350
Number of Twitter followers/tweets/retweets @CI HUB	350 / 500 / 35300	1247 / 789 / 82020	2171 / 601 / 83582	2231 /622 / 85632
Number of Facebook posts/likes	23 / 64	67 / 131	53 / 153	62 / 151
Number of videos/views/channel followers on YouTube	12 / 5323 / 10	23 / 9319 / 35	18 / 3076 / 24	21 / 2064 / 32

beginning, the team were advised by two expert entrepreneurs who acted as mentors of the initiative and the first start-ups. Quickly, the initiative became known at regional level and created great expectations, so it was easy to recruit a few mentors and a business angel for the first edition. Following this, targeted dissemination activities were launched directed to specific target groups (entrepreneurs, start-ups, mentors, coaches, business angels and venture capital groups). Investors, mentors and coaches were recruited inviting them to participate in Cloud Incubator Afterhours events, demo-days and midterm evaluations. Once they could see first-hand the results obtained by the start-ups, they offered their support. In this way, the task of recruiting the necessary experts for future editions of the programme was built into the design of the programme itself.

5.2 Strategic use of social networks

Open Calls for the incubation/acceleration programmes, training and networking activities were made known to the global entrepreneurial ecosystem through a strategic use of social networks (Facebook, Twitter, LinkedIn and YouTube). This strategy was based on attracting university students of our Region from these networks offering free training material, and publishing news on our blogs and YouTube videos. For this, it was necessary to set-up a Web site with relevant information about the Cloud Incubator HUB [27] and publicise these activities throughout social networks. Table 4 shows the evolution of the social media indicators collected along the first four years of the initiative. In our experience, it was relatively easy to get Twitter followers while growing in Facebook was more time consuming. One of the reasons for this is the fact that our entrepreneurs very frequently use Twitter as a communication channel; when news about them is tweeted, the HUB brand is quickly propagated throughout the network.

5.3 A start-up incubator/accelerator programme specialised on mobile technologies and IoT

A number of key performance indicators (KPIs) have been captured to monitor the impact of the

Table 5. Key performance indicators (kpi) have been captured to monitor the impact of the hub and enable effective management of the progress towards goals.

	Results			
Key performance indicator (KPI)	**1st Edition Jan. 12–Aug. 12**	**2nd Edition Sep. 12–Apr. 13**	**3rd Edition Sep. 13–Apr. 14**	**4th Edition Sep. 14–Apr. 15**
Number of start-ups at the beginning of acceleration programme (entrepreneurs in brackets)	18 (55)	13 (33)	12 (27)	13 (39)
Number of start-ups that finish acceleration programme (entrepreneurs in brackets)	10 (32)	9 (19)	10 (18)	9 (25)
Number of successful start-ups a year after (and entrepreneurs in brackets)	6 (24)	5 (9)	5 (12)	N/A
Number of successful star-ups a year after according development stages* (Validation/Scaling/Establishing)	3 / 1 / 2	0 / 3 / 2	1 / 2 / 2	N/A
Number of successful star-ups two years after according development stages* (Validation/Scaling/Establishing)	1 / 1 / 3	0 / 1 / 4	N/A	N/A

* To assess the degree of start-ups maturity have been considered the stages of the start-up journey described by Start-up Commons Org [33].

HUB and enable effective management of the progress towards goals (see Table 5). These indicators and metrics have provided a high level of feedback of the ecosystem impact and critical information about its future sustainability through its commercial exploitation. The information has also served to improve and validate the developed acceleration programme, as well as the online platform, procedures and content.

Although the number of data is not very high because the experience is relatively young (4 years), it can be observed that the success rate obtained of the acceleration stage is about 16% after 2 years of completing the first edition and 11–15% after one year. The success rate is calculated as the percentage of start-ups that reach the establishing stage. The start-ups created during the four editions and further information about them and their products can be found in [18].

5.4 Looking for efficiency in the incubation/acceleration process

A crucial task of any incubator/accelerator is to help start-ups crossing the "valley of death" [28]. This is a common term in the start-up world, referring to the phase between research and successful innovation. Its length is related with the difficulty of recovering the negative cash flow in the early stages of a start-up. Just in case of sustainable positive cash flow generation, the start-up will be able to survive the aforementioned "valley of death". Our support to enable start-ups to income as early as possible directly affects the start-ups success and thus, the efficiency of the acceleration process. This focus on efficiency in the start-up process has gathered further relevance due to the Lean Thinking principles [29]. According to these principles, most start-ups fail because they do not find clients willing to pay enough for the products or services offered. If the method of the five whys [30] to determine the efficiency of the resources used in accelerating a start-up is applied, it could be deduced that resources would have been wasted on something that did not fit to the market needs. These resources are usually money, time and effort used for developing a product without having learned efficiently how you can adapt that product or service to a particular market segment. In other words, for Lean Thinking the focus in the development of a start-up should be put in the iterative search and validation for a profitable, repeatable, and scalable business model; i.e., the search for a service or product and a customer who wants to buy it, and how to obtain revenues from the customers. This approach marks a departure from more traditional methods where massive amounts of resources and funds are spent on product development, business plans and financial forecasts and only then are market tested.

For these reasons the Lean Thinking trend was adopted as the basis for our intensive incubation/acceleration programme in the early stage of start-ups incubation and in the acceleration phase. Together with this vision, many other contextual and economic factors contribute to improving the efficiency of incubation/acceleration processes. These factors concern the cost and easy access to technology and resources that until recently were only accessible to large corporations. In addition, being within a university context also provides access to resources that would otherwise be difficult to find:

- Tools and Open Source Applications, which allow executing and modifying the software and even distributing it modified (e.g. Android, Ubuntu, Debian, etc.).

- Cloud Applications (Software as a Service) for developing social networks, e-shops, games, education platforms, etc. Many of them under a GPL license, allow implementing businesses for a few hundred dollars, and even free.
- Communities to develop Open Hardware. They enable to build a wide variety of consumer electronics prototypes (interactive objects, robots, drones, home automation, data-loggers, etc.) for a few hundred euros (e.g. Arduino).
- Offshore manufacturing of fast moving consumer goods. It allows the outsourcing of manufacturing processes for large and even small quantities of products at very reasonable cost and easily accessible by the start-ups.
- VC investment groups and networks of business angels. They contribute capital to start-ups and companies with high growth potential and high levels of risk in return for a percentage of the company. Total private equity investment in 2002 totalled €36.5bn in nearly 5,000 European businesses, of which €3.2bn were venture capital investments in 2,900 companies [31].
- Crowd funding as a very unique formula of patronage where the funding comes from multiple sources. Users of the platform that are identified with a start-up contribute with small amounts of money to finance the implementation of an initiative. The OUYA video console and Pebble smart watch are examples of projects that have been funded through the Kickstarter platform [32].

5.5 Lessons learned

From this four-year experience we have obtained the following lessons learned developing a University entrepreneurial ecosystem and acceleration programme to facilitate students a successful development of entrepreneurial skills and new businesses:

1. From the academic point of view, students are greatly benefited by participating in the HUB regardless of the business success achieved by them. They improve their knowledge, skills and attitudes in many fields. It is also an opportunity for the creation and evolution of their own ICT entrepreneurial company. The students are in touch with professionals and researchers, not only in various different branches of engineering, but also in non-technological disciplines.
2. When students discovered our programme was focused on a particular domain (IoT) their interest in the programme was much greater. Specialised accelerators are able to attract a more talented and focused entrepreneur than acceleration programmes with a general purpose.
3. Despite being a new initiative that has been developed in a region of Europe where there were no similar previous experiences, our success rates are very similar to those of other, more consolidated accelerators.
4. We have found that the use of the renowned Lean Thinking approach allows us to accelerate the start-ups development process in an efficient way by reducing: (1) time to first purchase by using customer development methodology, (2) product development times by using an agile development methodology, and (3) the risk of developing products without testing market acceptance and consequently reducing the rework costs. We have also verified that this methodology is well adapted to the mentality of our engineering students, accustomed to using scientific methods in the course of their work.
5. We have observed that much remains to be done in the stages before the start-up incubation (ideation, conception and commitment). Currently, we address this stage in two months with a few workshops and working on a business model canvas. The result is a high abandonment rate (60%). The reasons for this include the heterogeneity of the entrepreneurs that access the incubation programme. They are entrepreneurs and start-ups with very different levels of maturity and with different levels of commitment. Much remains to be done standardise the process at which entrepreneurs come into the programme.
6. It is very important to enhance and improve the collaboration and efforts of entrepreneurship initiatives (hubs, incubators, accelerators, investors, etc.), ICT business experts (accelerators, mentors, coaches, etc.), academic actors (researchers, professors and trainers) and the students as the final beneficiaries (through student networks, their alumni and student entrepreneurship centres). Networking with other start-ups is an activity very much demanded by the start-ups.
7. There is a lack of knowledge in issues related with accessing international markets and marketing. Many start-ups and potential investors that come from traditional sectors request contact with investors specialized in technology.
8. Demo-days are not seen as a value-added activity by growing start-ups. Many start-ups feel uncomfortable with these shows, not least due to issues related to IPR. The large number of demo events on offer also makes it difficult to convince start-ups of the benefits of participating.

9. Finally, our experience has highlighted the need for the acceleration programme to be very well defined. Financial incentives can also be an important factor that affects start-ups decisions on whether to apply or not.

6. Conclusions

The success enjoyed by high profile accelerators in the US has led to the replication of programmes in other parts of the world. These accelerators owe their success to the activation of vibrant entrepreneurial ecosystems that place contacts, funding and know at the service of the start-ups they support. Our research confirms that there is a growing trend to build upon this model and incorporate entrepreneurship into the wider Higher Education curricula across the European Union. Acceleration programmes differ according the size of country and the characteristics of their education systems. Nevertheless, at the time of the research, entrepreneurship modules tended to be more present in business courses with little or no technological component. The prevalence in engineering degrees is much lower. This suggests a disconnect with economic and social trends, which show technology start-ups creating more jobs and wealth that other firms.

Our research has tested a model to take aspiring entrepreneurs to successful start-up in the last year of their engineering degrees. It has covered 261 engineering students over a four-year period (2012–15). In this period, 56 start-ups based on mobile or Internet of Things technologies have created and 38 have survived after the end of the accelerator programme. We have found that in addition to providing specific training that enhances their entrepreneurship skills, it is necessary to provide them with technology labs that they can use to build working prototypes that can be quickly launched and validated. We have also found it necessary to provide a legal structure from which the entrepreneurs can start to take their products and services to the market and test adoption and other market hypothesis without incurring the expense of setting up formally as a business or a sole trader. This has helped them survive the Valley of Death in which many cash-starved start-ups falter.

Early data revealed that we needed to offer a two-stage programme: an incubator, for students with a business idea (concept stage) and an accelerator for those who were able to take the concept to early-stage start-up. The lean start-up methodology has provided a useful framework for the programme. We have also found that regardless of whether students go on to launch successful companies, the contact with other disciplines through the wider research and business network during the incubation and acceleration stage brings longer terms benefits. The level of interest and commitment has been greater in those programmes that focused on start-ups based on specific technologies, such as IoT. In contrast, interest in Demo days, a staple of many acceleration programmes, has remained low, reflecting concern over intellectual property issues, amongst other things.

The experience shows that a University can play a pivotal role in galvanising the local investment community and creating an effective ecosystem of mentors and investors. The early stages of ecosystem building require a considerable amount of effort and communication. Once established, it has been shown to grow more organically and, through the success of the start-ups incubated, more self-sustaining.

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References

1. EU Employment and Social Situation, Quarterly Review, *European Commission*, 2015.
2. T. S. Lyons, S. Li and B. Zhao, The state of the Wisconsin incubation industry in 2002: an analysis of the results of the survey of membership. Report prepared for *The Wisconsin Business Incubator Association*, 2003.
3. A. Bollingtoft and J. P. Ulhoi, The Networked Business Incubator—Leveraging entrepreneurial agency?, *Journal of Business Venturing*, **20**(2), 2005, pp. 265–290.
4. L. Peters, M. Rice and M. Sundararajan, The Role of Incubators in the Entrepreneurial Process, *Journal of Technology Transfer*, **29**(1), 2004, pp. 83–91.
5. S. A. Mian, University's Involvement in Technology Business Incubation: What Literature and Practice Tell Us?, *Int. Journal of Entrepreneurship and Innovation Management*, **13**(2), 2011, pp. 113–121.
6. Entrepreneurship 2020 action plan: Reigniting the entrepreneurial spirit in Europe, European Commission, 2012, Communication COM 795.
7. Jed Christiansen, Copying Y Combinator: A framework for developing Seed Accelerator programs, *MBA thesis at the University of Cambridge*, 2009.
8. G. Secundo, A. Romano, G. Passiante and P. Del Vecchio, Entrepreneurship and Engineers: developing an entrepreneurial mindset in High Technology Industry, *Proceedings of IFKAD, Institute of knowledge Asset Management*, 2013.
9. T. Kriewall and K. Mekemson, Instilling the entrepreneurial mindset into engineering undergraduates, *The Journal of Engineering Entrepreneurship*, **1**(1), 2010, pp. 5–19.
10. G. Elia, A. Margherita, G. Secundo and K. Moustaghfir, An activation process for entrepreneurial engineering education: the model and application, *Journal of Enterprising Culture* **19**, 2011, pp. 1–22.

11. Entrepreneurship in Higher Education, Especially in Non-Business Studies, *European Commission*, Enterprise and Industry Directorate-General, 2008.
12. D. F. Kuratko, The emergence of entrepreneurship education: Development, trends and challenges, *Entrepreneurship: Theory and Practice Journal*, **29**(5), 2005, pp. 577–597.
13. European start-up initiative, *European Commission*, 2014.
14. M. Täsk, P. Tynjälä, M. Toding, H. Kukemelk and U. Venesaar, Engineering Students' Experiences in Studying Entrepreneurship, *Journal of Engineering Education*, **103**(4), 2014, pp. 573–598.
15. N. Duval-Couetel, T. Reed-Rhoads, S. Haghighi, Engineering students and entrepreneurship education: Involvement, attitudes and outcomes, *Int. Journal of Engineering Education*, **28**(2), 2012, pp. 425–435.
16. A. Jamison, A. Kolmos and J. E. Holgaard, Hybrid Learning: An Integrative Approach to Engineering Education, *Journal of Eng. Education*, **103**(2), 2014, pp. 253–273.
17. L. Leydesdorff, The Triple Helix Model and the study of knowledge Based Innovation Systems, *Int. Journal of Contemporary Sociology*, **42**(1), 2005, pp. 12–27.
18. A. Bergek and C. Norrman, Incubator best practice: A framework, *Technovation*, **28**(1–2), 2008, pp. 20–28.
19. H. Chesbrough, Business Model Innovation: Opportunities and Barriers, *Long Range Planning*, **43**, 2010, pp. 354–363.
20. A. Osterwalder and Y. Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, *Strategyzer Series*, 2009.
21. S. Blank, Why the Lean Start-Up Changes Everything, *Harvard Business Review*, 2013.
22. A. Osterwalder, The business model ontology: A proposition in a design science approach, *Institut d'Informatique et Organisation, Lausanne, Switzerland, University of Lausanne, Ecole des Hautes Etudes Commerciales HEC, 173*, 2004.
23. S. Blank, The four steps to the Epiphany: Successful Strategies for Products that Win, *Steve Blank, 2nd Edition,* 2003.
24. D. Rancic-Moogk, Minimum Viable Product and the Importance of Experimentation in Technology Start-ups, *Technology Innovation Management Review*, 2012, pp. 23–26.
25. S. Nerur, R. Mahapatra and G. Mangalaraj, Challenges of migrating to agile methodologies. *Communications of the ACM*, **48**(5), 2005, pp. 72–78.
26. F. T. Rothaermel and M. Thursby, Incubator firm failure or graduation? The role of University linkages, *Science Direct. Ed. Elsevier*, 2005.
27. Cloud Incubator HUB, http://cincubator.com/, Accessed 5 May 2016.
28. Y. Osawa and M. Kumiko, An empirical analysis of the valley of death: Large-scale R&D project performance in a Japanese diversified company, *Asian Journal of Technology Innovation*, **14**(2), 2006, pp. 93–116.
29. J. Womack and D. Jones, Lean Thinking. Banish Waste and Create Wealth in Your Corporation, 2003.
30. O. Taiichi, Toyota Production System: Beyond Large-Scale Production, *Hardcover*, 1988.
31. Access to finance, Venture capital, *European Commission*, 2014.
32. *Kickstarter*, http://www.kickstarter.com/help/stats, Accessed 5 May 2016.
33. Start-up key stages, *Start-up Commons*, 2014.

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