Regional Innovation Impact Assessment Framework Case Study KU Leuven

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1 Introduction of the university in its regional context

1.1 The region

The KU Leuven is located in the community of Flanders, which is the northern part of Belgium and home of about 6.5 million inhabitants out of a total of 11.4 million in the entire country (Statbel, 2018). It is an innovative and prosperous region in a country whose GDP per capita rose to €38,500 in 2017 compared to €30,000 for the EU-28 average (Eurostat, 2018). It should be noted that in the early nineties, political decisions in Belgium moved the center of gravity of science and innovation policy from the federal to the community and regional level. For KU Leuven this means that all innovation and education policies are made at the level of Flanders, which has been classified as an innovation leader while Belgium as a whole is part of the group of strong innovators (European Innovation Scoreboard, 2018). The total R&D intensity in Belgium and Flanders respectively reached 2.6% and 2.89% of GDP in 2017, narrowing the gap with the Europe 2020 target of 3% of GDP and being above the EU-28 average of 1.96% (ECOOM, 2019). The government input for R&D in Flanders is above the EU-28 average (GBARD as % of the GDP): 0.75% versus 0.56% in 2017 (Speurgids, 2019). Belgium also has a relatively highly educated population: 44.3% of people aged 25-34 had completed tertiary education (ISCED 5-8) in 2016, compared to 38.2% in the EU-28. The country has an excellent science base: 12.6% of the country's scientific publications was among the top 10% most cited publications worldwide in 2014 (EC-RTD, most recent data available) compared to EU-28 average of 11.08%. In terms of technological performance, Flanders occupied the 9th position in terms of the number of European Patent Office patent applications per million inhabitants in 2012 compared to a reference group of countries that jointly account for 95% of global patenting activity (Vlaams Indicatorenboek, 2018). 57% of Flemish companies was innovative in the period 2012-2014 according to the Eurostat definition.

1.2 The university

The KU Leuven was founded in 1425 and is one of the oldest universities in Europe. In 2017, it had about 57,000 registered students (of which 17% international), which makes it the largest in Belgium. It has about 12,000 staff members complemented by some additional 8,000 full time equivalent staff in the university hospital. It is a comprehensive, research-intensive university encompassing 16 faculties that are organized in three groups: Science & Technology, Biomedical Sciences, and Humanities & Social Sciences.

The KU Leuven forms a network with five university colleges across Flanders and Brussels in the 'KU Leuven Association'. This Association was founded in 2002 in response to the Bologna Declaration of 1999, which sought to increase synchronisation of higher education systems in Europe. Its university colleges account for some additional 50,000 students distributed over 21 campuses. In total the Association KU Leuven represents about 42% of the total Flemish student population. Its members exchange expertise and pool resources, with the aim of improving the quality of teaching and research.

As reported in more detail in section 4, the KU Leuven is not only an important contributor to Belgium's scientific performance as far the quantity of scientific output is concerned, but it also excels in terms of quality. To illustrate this: about 3% of its publications are in the highly selective top 1% of the citation distribution and its normalized citation impact indicator is 1.7 in 2015, showing that the university's research reaches an above-average impact (InCites 2015). In line with the innovative performance in the business sector, the KU Leuven was named Europe's most innovative university based on the Reuters ranking of 2016, 2017, 2018 and 2019. As the highest-ranked Belgian university, the KU Leuven has been ranked 48th in the Times Higher Education ranking 2019, and has been consistently among the top 50 universities in the world in recent years.

2 Regional orientation, strategic development and knowledge infrastructure

2.1 Main revenue streams

The overall revenues of the university are divided in five so-called 'funding streams'. The **first funding stream** refers to the working budget allocated by the Flemish government, which in 2018 accounted for €412 million or almost 40% of the university's budget (KU Leuven, 2018 annual report). The **second funding stream** is the government allocation for fundamental research (€131 million), which is mostly distributed via the Science Foundation Flanders (FWO, €57 million) and the Special Research Fund (BOF, €71 million). The **third funding stream** pertains the government issued funding for applied research (€146 million). A large part of this stream comes from the subsidies for applied research allocated by FWO (strategic basic research or applied biomedical research) and the agency Flanders Innovation & Entrepreneurship VLAIO (combined €27 million) and the Industrial Research Fund (IOF, €15 million). However, more than 39% (€57 million) of the third funding stream originates from international institutions, the majority being funding from European Framework programmes such as the Horizon 2020 programme. The **fourth funding stream** is composed of revenue from scientific services and contract research with the private sector, which accounted for €135.7 million in 2018. Finally, the **fifth funding stream** includes various remaining revenue sources (€93 million), amongst others tuition fees. Taken as a whole, the KU Leuven registered €1.002 billion of revenues and €953.3 million of expenditures in 2018. Research expenditures accounted for €476 million, comparable to the expenditures of 2017 (KU Leuven, 2018 annual report). The Leuven University Fund (LUF) is the entity for endowments and sponsorship at the university. It advises alumni, companies and others who want to make a donation to the university, as well as professors who want to set up a project to acquire external funds. The total revenues of LUF in 2018 were €21.6 million and there are currently 199 active funds and 107 research chairs.

2.2 Strategic partnerships

In order to leverage its impact on society, the KU Leuven has forged strategic partnerships with many other actors in the Flanders region, as well as world-wide. These collaborations occur at various levels, starting from the local and regional to the national and international level.

Locally, the university very regularly consults with its local stakeholders, such as the Leuven based interuniversity microelectronics center (Imec[1]) and the city council members of its hometown, the city of Leuven. This regular consultation first led to the creation of Leuven.inc[2] in 1999. Since 2016 these interactions have been further consolidated leading to the establishment of the 'Leuven Mindgate[3]' initiative to enhance the city's regional branding. In addition, KU Leuven has built strong ties with several other cities in Flanders including Genk and Kortrijk allowing the university to extend its network of science parks and incubators. There are also very intense collaborations with the province of Flemish Brabant in order to promote the entire region as a knowledge hub to attract foreign companies, via an initiative called "Flanders Smart Hub[4]". Setting up networks like these helps speed up the 'Brownian motion' process that results in serendipitous connections, as other successful university-based clusters - such as the one in Cambridge[5] - have demonstrated.

(1) Interuniversity Microelectronics Center, https://www.imec-int.com/en .
(2) https://www.leuveninc.com/
(3) https://www.leuvenmindgate.be/
(4) https://www.smarthubvlaamsbrabant.be/international/
(5) http://www.cambridgephenomenon.com/

At the ***Flemish government level***, the university collaborates with agencies like Flanders Innovation & Entrepreneurship (VLAIO, the main channel for innovation support for companies and universities, see section 1), Science Foundation Flanders (FWO, the main funding agency for fundamental and basic research, see section 1), the Department of Economy, Science and Innovation (EWI) of the Flemish Government, Flanders Investment and Trade (FIT, the agency for support to exporting companies) and the innovation centers (local offices that provide low-threshold innovation support to companies).
Within the ***broader region***, KU Leuven is actively involved in cross border collaborations, such as ELAt, a network linking the knowledge regions Eindhoven, Leuven and Aachen, forming a European technological top region (ELAt stands for the 'Eindhoven-Leuven-Aachen-triangle). ELAt was started as an INTERREG[6] project with partners from these three cities: two regional public authorities (the Eindhoven Regional Government (SRE) and the regional development agency of the Aachen region (AGIT)), and KU Leuven represented by its TTO – KU Leuven Research & Development (LRD).

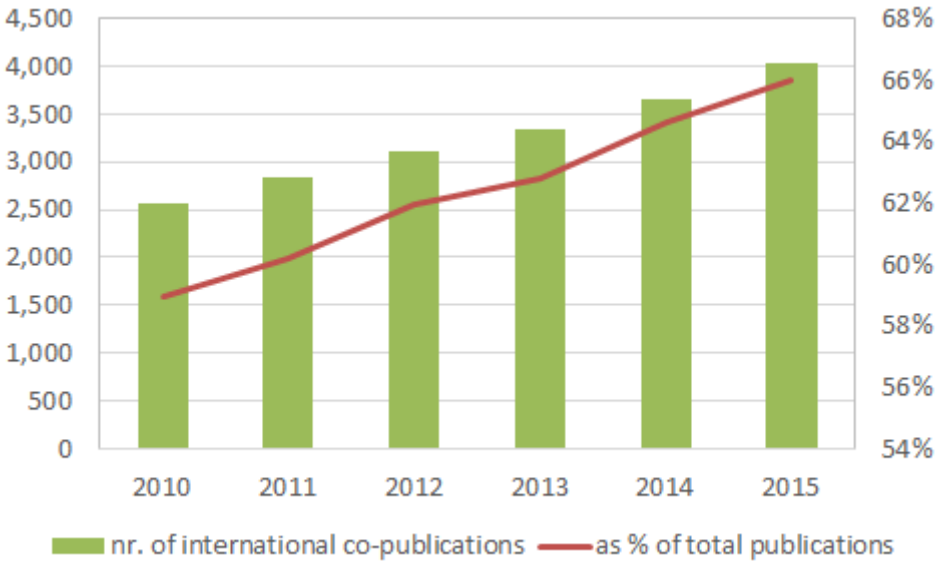
Box 1. Interregional collaboration.

The ELAt collaboration (Eindhoven/Leuven/Aachen) has resulted in the establishment of a "masterclass starters", which is a coaching programme for high-tech entrepreneurial teams. It is co-organised on yearly basis by several universities including KU Leuven and the Technical University of Eindhoven (TU/e). Another example of interregional collaboration is Nano4Sports, an INTERREG project coordinated by KU Leuven that aims to stimulate innovation in the sports and health domain, using a 'living lab' approach and focusing on technologies on the level of sensors, data communication, analytics and user implementation.

At the **European level**, several KU Leuven research centers collaborate with Flemish spearhead clusters – large-scale Triple Helix initiatives addressing strategic domains which receive public support for 10 years – and internationally prominent research groups.
Also scientifically, the KU Leuven plays a key role in connecting the regional innovation system to international networks. To illustrate, Figure 1 shows the growth in the number of scientific publications with international co-authors and how these international co-publications account for a growing share of the university's scientific output, up to ⅔ in 2015 (InCites 2015).

(6) https://www.interregeurope.eu/

Figure 1. Scientific publications with international co-authors[7].



Source: InCites Dataset, data exported 11.07.2018.

Box 2. EU Knowledge and Innovation Communities.

KU Leuven is a very active participant in the Knowledge and Innovation Communities (KIC). These KICs are partnerships that bring together businesses, research centres and universities and are initiated by the European Institute of Innovation and Technology (EIT) via a competitive application procedure whereby only the strongest consortia receive a KIC label. In this context, KU Leuven has typically contributed to these KICs through clusters around its research activities. As an example, the KU Leuven Materials Research Centre (LMRC[8], an interdisciplinary initiative on materials research) has since 2015 taken up an active role in the **KIC Raw Materials**, closely collaborating with both the partners in the Co-Location Center West (CLC) in Leuven and with the international KIC partners. Along the same lines, the Leuven Medical Technology Centre (LMTC[9], an interdisciplinary research initiative combining engineering sciences and biomedical sciences) was from the start actively involved in the **KIC Health** in which KU Leuven is a core partner through the consortium Innolife. The same goes for KU Leuven's initiative in clustering energy related research (together with the Flemish Institute for Technological Research (VITO), imec and the University of Hasselt) into the joint research center Energyville[10], which has taken a leading role in the **KIC InnoEnergy** and for the KU Leuven Food and Nutrition Research Center (LFoRCe[11]) which is actively involved in the FoodConnects consortium that was selected by EIT as the consortium responsible for managing the **KIC Food**.

(7) The number of international co-publications counts those KU Leuven publications with at least one other country (besides Belgium) among the affiliations of the co-authors. The red curve indicates the number of international co-publications of the KU Leuven divided by its total number of Web of Science publications (of the types Article, Note, Letter or Review) in the respective year.
(8) https://set.kuleuven.be/mrc
(9) https://set.kuleuven.be/lmtc
(10) https://www.energyville.be/en
(11) https://lforce.kuleuven.be/

At the **institutional level**, the KU Leuven is actively engaged in several international networks, such as the Health Axis Europe[12], a strategic alliance with the biomedical clusters in Heidelberg (Germany), Maastricht (Netherlands) and Copenhagen (Denmark). KU Leuven also actively participates in professional associations on knowledge transfer such as Proton-ASTP[13] (Association of European Science & Technology Transfer Professionals) and AUTM[14] (Association of University Technology Managers). The university is also founding member of initiatives such as the Conference of European Schools for Advanced Engineering Education and Research (CESAER[15]) and the League of European Research Universities (LERU[16]) which serve not only as meeting places to exchange best practices amongst peers, but also as places to engage in policy making at EU level.

(12) https://www.health-axis.eu/
(13) https://www.astp4kt.eu/
(14) https://autm.net/
(15) https://www.cesaer.org/
(16) https://www.leru.org/

3 Education and human capital development

3.1 Staff

One of the strategic objectives of the university TTO (LRD) is to deepen and support a culture of innovation and entrepreneurship and to develop the necessary capabilities to do so (KU Leuven Research & Development, 2017). A variety of voluntary training initiatives helps to instill an entrepreneurial mindset among staff. Examples of such initiatives are a residential 3-day master class in entrepreneurship[17] and a modular 5-day training programme on research valorization for doctoral and post-doctoral researchers[18]. In the latter initiative, the researchers are coached by seasoned university business developers, which greatly contributes to realizing a university-wide entrepreneurial mindset.

In collaboration with the research coordination office of the university, the TTO also organizes joint information sessions for newly hired faculty members. In these sessions information is exchanged about, amongst other things, funding channels for applied research (both at local as well as international level).

Internationalization is an important part of the human capital development policy. For instance, new faculty members are required to have taken up a visit or project at a foreign university for a minimum of six consecutive months. If this requirement is not met, a compulsory research visit of at least six months at a prominent foreign university is required as one of the conditions of the tenure track. Tenured faculty have several possibilities to take up positions abroad, with regulations to facilitate mobility. For example, there is the possibility to take up a research, teaching or consulting position in addition to a full-time appointment. Such a position can consist of a maximum of 20% above the 100% appointment. The additional position is assessed to ensure it can be combined with a full time appointment and that it is consistent with the KU Leuven's policy. Faculty can also obtain a temporary affiliation at another institution (national or international) on condition the institution reimburses the KU Leuven for the appointment, or can apply for a temporary reduction in order to take up a position elsewhere. The arrangement for such a temporary reduction is flexible, as it gives the faculty member the option to return to a full time appointment for a maximum of eight consecutive years. To promote international mobility of assistants and professors, enforceable rights have been created, such as the rule that every professor who is not older than 60 and has at least 15 years of seniority is given the right to a sabbatical year or at least a sabbatical semester.

3.2 Students

In 2016, the KU Leuven set up the Student Career Center (SCC) which acts as a one- stop shop for all career and employment related matters for its students. As the largest university in Belgium with a broad spectrum of educational fields (organised in 16 faculties), KU Leuven has a profound impact on (regional) employment. A survey held by the KU Leuven alumni services (for the academic year 2014-2015) among its master students indicate that 83% finds a job in less than 3 months and more than 98% in 12 months. About half (51%) of the recent graduates are employed in the private sector, 32% in government and 13% in health/welfare/socio-cultural sectors (KU Leuven alumni survey[19]).

Within the SCC, the Leuven Community for Innovation driven Entrepreneurship (Lcie, addressed in detail in section 5.3) takes on the responsibility for all entrepreneurship related matters. When it comes to bringing entrepreneurship within the educational system, a variety of programmes have been implemented:

([17]) See the ELAt example in Box 1.
([18]) See also: https://lrd.kuleuven.be/events/doctoral-school-training-course.
([19]) https://www.kuleuven.be/onderwijs/onderwijskwaliteit/bevragingen/alumnibevraging

- A first set of activities deals with **improving entrepreneurial skills**: Over the last years, various KU Leuven faculties have introduced courses on entrepreneurship both in the Master and Bachelor level curriculum. A portfolio of entrepreneurship courses based on these new courses are managed by the Lcie Academy - an interdisciplinary workgroup of professors lecturing in entrepreneurship - providing a certificate of entrepreneurship for students participating in the Lcie Academy. The portfolio is created such that students are required to take a variety of courses from different faculties, thereby promoting interdisciplinarity as one of the core values of innovation-driven entrepreneurship. Next to the Lcie Academy courses, other tracks, including a postgraduate entrepreneurial degree for engineering students as well as a Major Entrepreneurship for business students was established. In academic year 2017-2018, more than 1000 students participated in one or more of the Lcie Academy courses, in the postgraduate degree for engineers and/or in the Major Entrepreneurship (equalling some 1.75% of all registered students).
- A second set of activities focuses on how to **leverage initiatives** that originate within the Lcie community. These new initiatives often start as an extracurricular activity, but when successful, they may find their way into the official curriculum for certain study programs. In such cases, the Lcie Core team assists in this transition process. A first example is the course 'Product Innovation Project' (PiP[20]) which has been created by a group of students. It is based on a project-based learning format, whereby a multi-disciplinary team of students has to develop a solution to a given problem, delivering a prototype and a business case. The concept found its inspiration in similar initiatives developed at Aalto University[21] and Graz University of Technology[22] and was started at KU Leuven with three faculties that offered this course to their students. After four years of operation, the concept has been accepted in 14 (out of a total of 16) faculties. Noteworthy is the support from the faculties in bringing this format into the curriculum. For example, the faculty of engineering science has created a new course descriptor for PiP, that allows students to fully embed this project in their curriculum. This approach is now followed by several other faculties, demonstrating how bottom-up initiatives can become drivers of curricular change.

  In addition, several initiatives were developed by the student and academic community providing valuable support for entrepreneurial projects. A noteworthy example is IusStart, which is a legal clinic initiated in 2014 by PhD students from the faculty of Law, whereby students provide legal advice for startups. At present, the concept has been fully incorporated by the faculty of Law in the form of a Master thesis for law students. very academic year, some 10-to-20 IusStart law students provide (as part of their Master's thesis) legal advice to some 5-to-10 startups supervised by several PhD students and a number of law offices. Along similar lines, the 'TechStart' concept was initiated recently by PhD students from the engineering faculty, whereby engineering students provide technology advice to startups, thereby receiving ECTS credits.

(20) https://lrd.kuleuven.be/kuleuvenkick/english/skills/pip/index
(21) http://pdp.fi/
(22) http://product-innovation.at/

4 Research, technological development and knowledge transfer

4.1 An excellent research base

The excellence of the research done at KU Leuven is well illustrated by the number of Web of Science publications (co-)authored by researchers at KU Leuven, which has been increasing steadily over the last years, to 6,102 in 2015 (Incites data[23]). Over the 2007-2016 period, the KU Leuven published 47,742 publications in the SCI index, which attracted 901,262 citations (accounting for 42.9% of all citations received by scientific publications in Flanders). In the same time period, 6,269 papers were published in the social sciences and humanities (SSCI and A&HCI), attracting 39,741 citations in the SSCI-index, or 43.7% of all SSCI-citations in Flanders (KU Leuven, 2017 annual report). Furthermore, KU Leuven awarded 802 doctoral degrees in 2016-2017, of which 355 (44%) were awarded to non-Belgian researchers. The university also performs among the very best at a European level, with 107 ERC[24] Grantees (including affiliates with VIB[25] and Imec and incoming ERC-grantees) of which 55 Starting Grants. KU Leuven participated in over 540 projects in the 7th Framework programme (2007-2013), ranking sixth in the league of HES institutions. In Horizon 2020, KU Leuven maintains its sixth position with regard to number of participations and currently has had 260 projects approved, worth €145,9 million (KU Leuven, 2017 annual report). The university also attracts international research talent: in 2017, 33 of the 89 newly hired professors (37%) were non-Belgians (KU Leuven, 2017 annual report).

Internal networks for research valorization are started and supported via so-called research centres that tie in closely to the Flemish spearhead clusters (see section 2.2). These centres have – besides excellence in research – the explicit task to contribute to the creation of Centres of Excellence and breakthrough innovations through multidisciplinary collaborations. Examples include LMRC (materials), SIM²[26] (inorganic materials), Prometheus[27] (regenerative medicine) and the Leuven Brain Institute[28] (neuroscience).

4.2 The role of the technology transfer office

KU Leuven Research & Development (LRD) was established in 1972 as one of the first technology transfer offices in Europe with a mission to support the university staff in all aspects of research exploitation. Starting from the excellent science base at KU Leuven, LRD has developed a solid tradition of collaborating with industry, securing and licensing intellectual property rights, and creating spin-off companies. The support is given by a multidisciplinary team of over 100 experts who guide researchers in their interactions with industry and society, and help them to best leverage the societal and economic potential of their research. LRD is set up as a separate business unit within the university and plays a constructive role in the development of innovation policy in Flanders as well as in Europe. It actively collaborates with the government, amongst others with respect to the new cluster policy of the Flemish government, the grand challenges, smart specialization, Horizon 2020 and the other European policy instruments. Its support is tailored towards the three main valorisation pathways being research collaboration, intellectual property licensing and spin-off creation.

([23]) If both the Web of Science (SCIE, SSCI, AHCI, Proceedings) and Flanders' Academic Bibliographic Database for the Social Sciences and the Humanities are taken into account, scientific output rose to about 8,800 peer-reviewed publications in 2014-2015. These publications comprise journal articles, monographs, book chapters and conference proceedings (KU Leuven, 2017 annual report)

([24]) European Research Council, https://erc.europa.eu/

([25]) Vlaams Instituut voor Biotechnologie (Flemish Biotech Institute), http://www.vib.be/en/Pages/default.aspx

([26]) SIM² KU Leuven is a leading, interdisciplinary research cluster at KU Leuven uniting the research groups working on Sustainable Inorganic Materials Management, https://kuleuven.sim2.be/

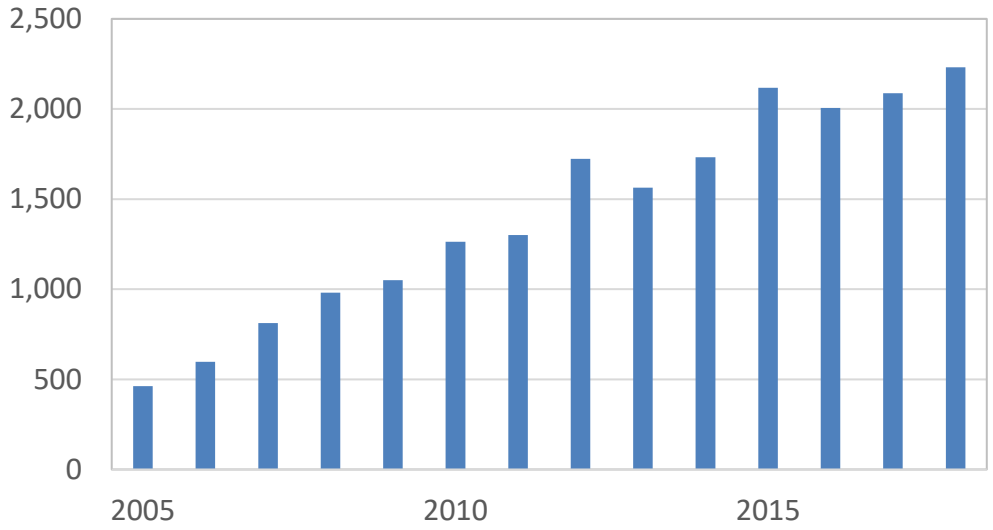
([27]) https://www.mtm.kuleuven.be/Prometheus

([28]) https://nieuws.kuleuven.be/en/content/2018/ku-leuven-presents-the-leuven-brain-institute

4.2.1 Research collaboration

A first important role of LRD is to manage all research collaboration agreements between the KU Leuven Association and industry, varying from small consulting assignments commissioned by a company to long term research projects. Figure 2 shows the number of new agreements (excluding Material Transfer Agreements and Non-Disclosure Agreements) that are being drafted by LRD every year. It is evident from the figure that these activities have been significantly increasing over the last decade and have not been influenced in a major way by the financial-economic crises.

Figure 2. Yearly number of new agreements (excluding Material Transfer Agreements and Non-Disclosure Agreements) that are being drafted by the university technology transfer office.



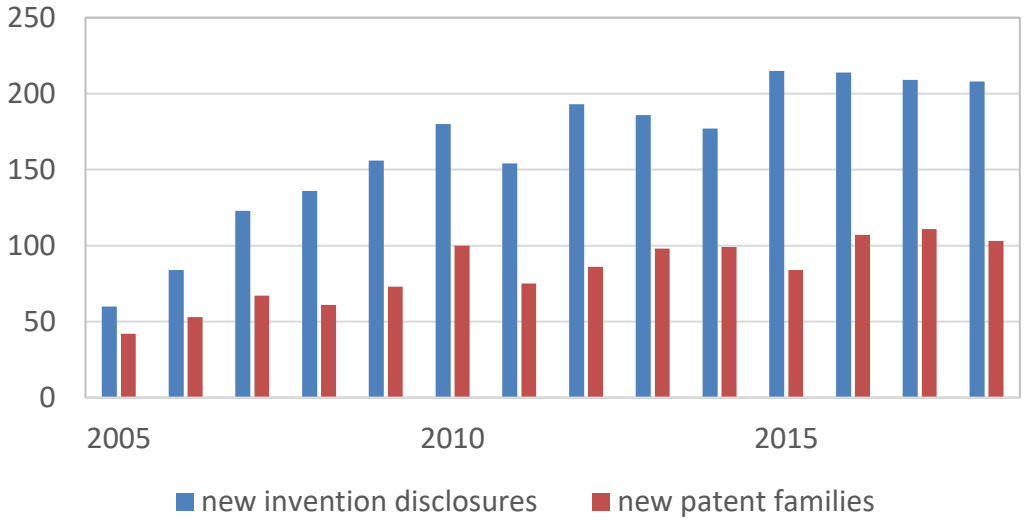
Source: annual reports KU Leuven.

4.2.2 Intellectual property

LRD's second activity is the commercialisation of the intellectual property of the KU Leuven Association, which requires an appropriate transfer strategy to ensure that innovation from research at KU Leuven finds its way into society. Figure 3 shows the number of reported inventions (referred to as 'new invention disclosures') as well as the resulting number of patent applications at the patent family level[29].

([29]) To avoid an inflated measure of patenting activity, the figure reports patent families rather than individual patents as some cases may warrant multiple patent applications for the protection of a single invention.

Figure 3. Number of new invention disclosures as well as the resulting number of patent applications at the patent family level.



Source: LRD brochure 2019.

LRD has an active policy of licensing its intellectual property. In 2018, a total of 50 new licenses on KU Leuven intellectual property have been signed (KU Leuven, 2018 annual report). This amount is comparable to licensing results from previous years and includes licenses and transfers on patents, patent applications and other intellectual property such as software, designs and databases.

4.2.3 Spin-off creation and business development

Besides these two main activities, LRD also actively supports the start of new ventures (spin-offs) and the realisation of science parks. Both items will be discussed in more detail in section 5.

4.3 Incentive mechanisms for academics

Regional legislation stipulates that in case of exploitation of an invention the inventors are entitled to a fair share of the proceeds. This provides a strong incentive for inventors to collaborate actively with LRD. KU Leuven has set up a flexible mechanism to manage these incentives in the form of so-called "LRD divisions". As it is the vision of KU Leuven that multidisciplinary collaboration is an important basis for innovation (KU Leuven Research & Development, 2017), these divisions are set up apart from the organizational structure of the university. At present, 77 divisions have been created. These divisions act as virtual companies within the university. They are maintained by LRD, independently from the central administration. The academics responsible for these divisions can invest the money they earn within the divisions, e.g. for hiring staff, for setting up a patent portfolio or for investing in spin-off companies. Since these investments are made with proceeds from other valorisation activities, academics tend to manage their operations carefully and allocate their resources efficiently. Some divisions also act as expertise centres, which take on the role of a vehicle that bridges the gap between scientific work and commercialisation via consultancy activities. This creates a cohort of people with the appropriate skill-set to advise businesses and, potentially, set up their own ventures.

Box 3. The KU Leuven division structure.

KU Leuven has set up 'divisions' which act as virtual, often interdisciplinary, innovation units within the university allowing researchers to engage with industry and society. Examples are the divisions INCENTIM[30] (International Centre for Research on Entrepreneurship, Technology and Innovation Management), Rega[31] institute for medical research (named after the 18th century philanthropist and professor Josephus Rega), PMA[32] (Production engineering, Machine design and Automation), MICAS[33] (Micro Electronics and Sensors), COSIC[34] (Computer Security and Industrial Cryptography) and DistriNet[35] (distributed systems)

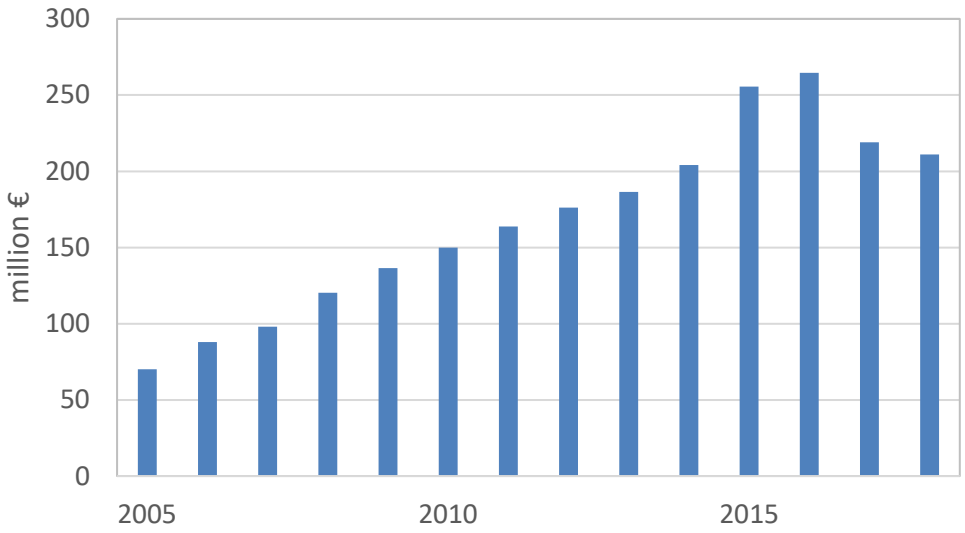
4.4 Financial leverage of valorisation

One of LRD's main operational objectives is to create financial leverage effects in order to support and further develop external funding that can complement within-university financing (KU Leuven Research & Development, 2017). Besides Flemish and federal funding, these efforts also explicitly target international funding sources and have contributed to KU Leuven's 6th position in the ranking of Horizon 2020 funding recipients, its participation in four KICs (see textbox on page 5) and in international programmes of institutions like the United States National Institutes of Health (NIH), the Wellcome Trust, and the Michael J Fox Foundation. By accessing these international funding channels, the university and the Flemish research and innovation system as a whole become further embedded in international R&D networks, which opens up new paths for research valorization. And in addition to the government and non-profit related funding streams, KU Leuven is also actively involved in setting up bilateral partnerships with the private sector which also adds significantly to this leverage effect.

The combined result of all these activities is summarized in figure 4 that shows the total revenue[36] of all valorisation activities that are supported by LRD.

(30) http://www.incentim.org/
(31) https://rega.kuleuven.be/
(32) https://www.mech.kuleuven.be/en/pma
(33) https://www.esat.kuleuven.be/micas/
(34) https://www.esat.kuleuven.be/cosic/
(35) https://distrinet.cs.kuleuven.be/
(36) The decrease in revenue starting in 2017 is related to a reduction in licensing revenues due to the expiration of the patent on Tenofovir, a drug that has been commercialised in collaboration with Gilead Sciences.

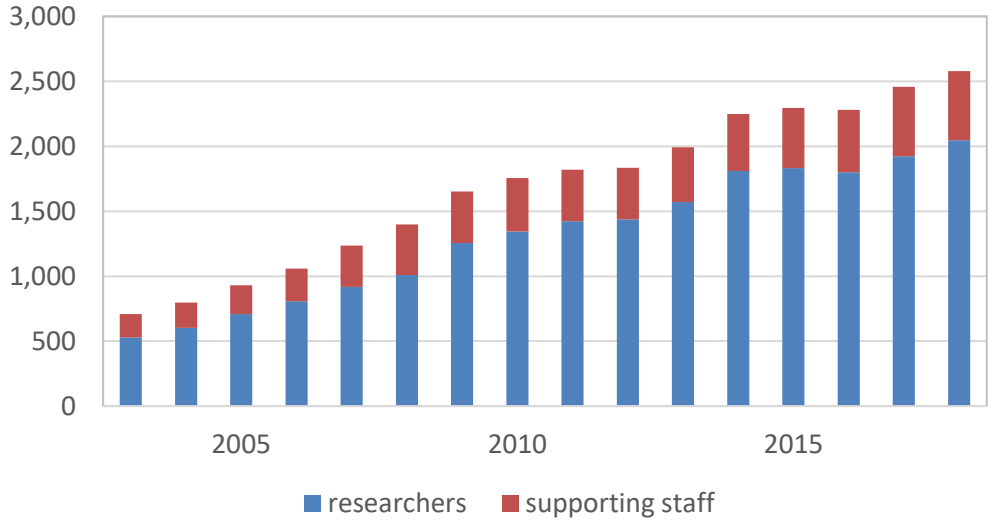
Figure 4. Yearly total revenue of all valorisation activities supported by LRD.



Source: annual reports KU Leuven.

Part of this revenue is used by academics to hire suitable R&D and support staff to sustain the valorisation activities. This is illustrated in figure 5, which shows that some 2,500 employees are being paid from the proceeds of all valorisation activities that take place at KU Leuven.

Figure 5. Number of employees at KU Leuven paid from valorisation activities.



Source: LRD brochure 2019.

Box 4. Collaboration on refined cochlear implants.

The Australian company Cochlear, a global leader in implantable hearing solutions, collaborates closely with several partners in the Leuven region. KU Leuven and Imec, together with the spin-off companies Easics, ICsense and AnSem, and the multinational company NXP Semiconductors have all contributed to refining cochlear implants. KU Leuven and Cochlear have partnered for more than twenty years. Cochlear develops hearing implants that use electrical stimulation, known as cochlear implants (CIs), which consist of two parts: a surgically implanted component that electrically stimulates the auditory nerve, and a speech processor worn externally that receives the sound and converts it into a pulsed electrical code. Specifically, the research is focused on developing software to process auditory signals in order to filter out noise so that CI users can perceive speech and music more easily. Researchers are also looking for new methods for auditory nerve stimulation, development of test platforms, and ways to improve perception of the direction from which an auditory signal is coming.

Box 5. Alternative ways to protect crops.

The introduction of invasive pest insects on the one hand and the more stringent regulations for pesticide use on the other hand are two major challenges for crop protection to date. To combat emerging crop pest insects, crop producers are in need of new compounds, new formulas for existing compounds, and novel and integrated strategies.

In order to meet the needs of these farmers, Globachem, an international agrochemical company based in Sint-Truiden (Belgium), and the KU Leuven Laboratory of Behavioral and Developmental Genetics have partnered to develop an alternative for traditional pesticides that is not or barely toxic using novel compounds and strategies to combat the Asian fruit fly.

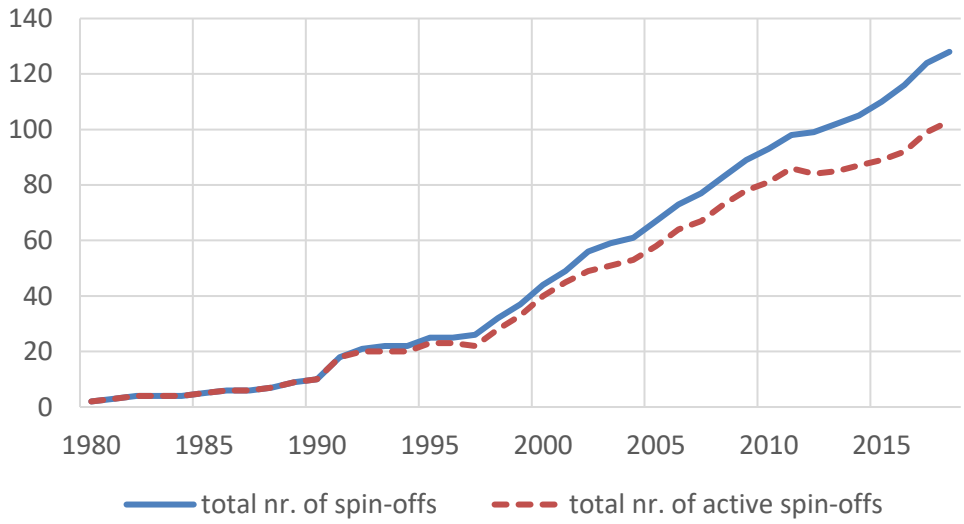
The collaboration project between Globachem and KU Leuven started in June 2017 for a period of two years with the aim of introducing new, less toxic products into the market to control pest insects, and especially the Asian fruit fly.

5 Enterprise development and entrepreneurship

5.1 Spin-off support

The support for venture creation at KU Leuven is based on a combination of decentralised sensitization towards entrepreneurship combined with a strong central support system. As indicated in the next section, a variety of funding schemes exist for researchers to bring their research closer to the market. In addition, the central support for and communication about impact that is reached with valorisation activities lowers the perceived barrier for entrepreneurial behaviour with researchers willing to engage in entrepreneurship. In the period 1979-2018, 128 spin-off companies were founded, of which 103 were still active at the end of 2018, as illustrated in figure 6.

Figure 6. Total number of spin-offs[37] started from KU Leuven and total number of spin-offs that are still active.

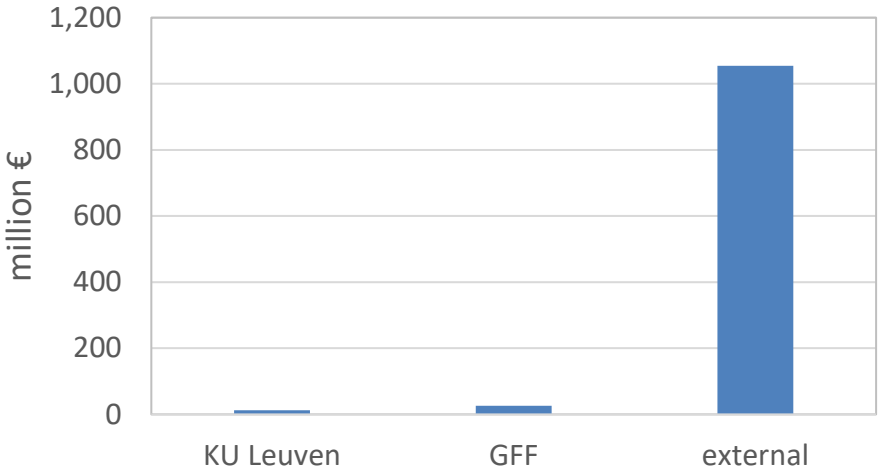


Source: LRD brochure 2019.

In the period 2005-2018, the KU Leuven, including its GFF fund (see below), invested €38.5 million in its spin-offs, while third-party investors matched this with €1,054 million, generating a leverage effect of 30:1 (Figure 7). In total, these new venture creation activities have resulted in a total job creation of about 6,700 new jobs (Figure 8).

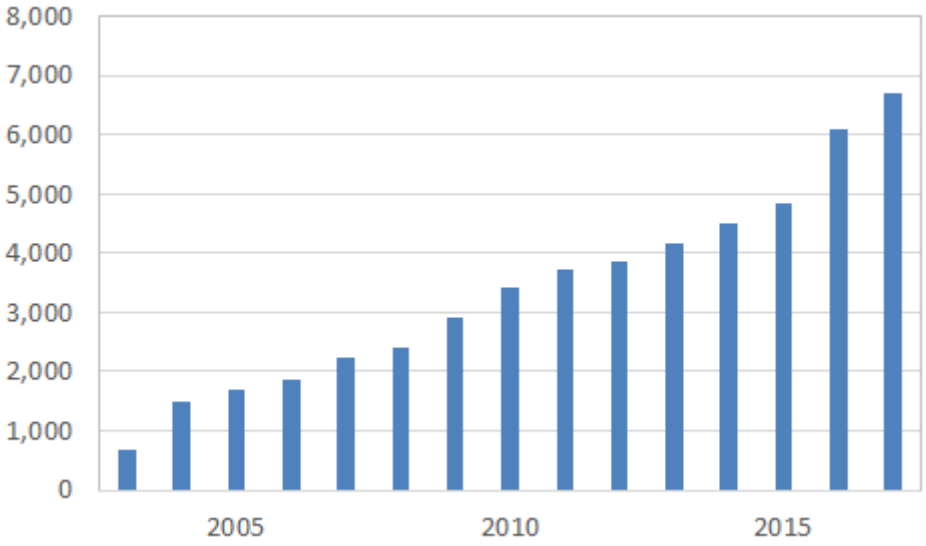
([37]) For clarity: a spin-off is a legal entity of which the university has become a shareholder as a result of a contribution of its intellectual property (license of transfer). Besides spin-off companies, several other entities are created with a link to the university, but these are not counted as spin-off.

Figure 7. Total investment in KU Leuven spin-off companies (2005-2018) by KU Leuven, the KU Leuven Gemma Frisius Fund and third parties ('external').



Source: LRD brochure 2019.

Figure 8. Employment numbers of the KU Leuven spin-offs.



Source: LRD brochure 2018.

5.2 Funding instruments for incubation

One of the key success factors of KU Leuven's enterprise development activities is the establishment of a set of complementary incubation funding instruments at various levels. These allow researchers to move up their research on the Technology Readiness Level (TLR) scale in order to bring it to a marketable product or service.

5.2.1 The Industrial Research Fund (IOF)

The industrial research fund has been set up by the Flemish Government in 2004 in order to stimulate and support the transfer of knowledge and especially in order to 'bridge the gap' between research and application. The fund is set up at Flemish level (i.e. it serves all five universities in the community) and has increased from some €10 million in 2005 to some €32 million in 2018 and a further substantial increase of €20 million in 2019. The funds of IOF are distributed over the Associations[38] according to a set of measurable performance indicators, including industrial contracts, EU projects, patents and spin-offs. Based on these parameters, the share of KU Leuven in the overall IOF funding amounts to some 46%, totalling about €15 million in 2018. This funding is used in two types of funding schemes:

- A first use is **mandate-based** funding whereby so called 'IOF mandate holders' are funded: these are individuals that act as research managers. They are embedded within the research groups and act closely with the professors that have applied for this mandate. In total, some 35 full-time staff are being employed in these activities, spanning across a broad range of research domains.
- A second use is **project-based** funding. These project-based grants, the so-called "C3 projects" aim at research that is economically or socio-economically driven, with expected payoffs in a short timeframe, i.e. two years. These projects respond to needs from one or more sectors of society, with stakeholders that are already identified at the start of the project and with a clear valorisation plan that may include entrepreneurial activities such as obtaining IP protection, development of prototypes, further market validation, etc. In addition to these C3 projects, IOF funds are also used to support strategic basic research (referred to as "C2 projects") which is targeted at advancing fundamental research results towards societal or economic goals and at setting up partnerships with companies and/or other stakeholders. On average, some 30 projects are started each year.

5.2.2 The Gemma Frisius Fund

The Gemma Frisius Fund (GFF) is a seed capital fund that was established in 1997 as a joint venture between KU Leuven and the banks KBC and BNP Paribas Fortis. The objective of the fund is to stimulate the creation and growth of KU Leuven spin-off companies. Over the years, the GFF has invested €32 million in 51 KU Leuven spin-off companies and since 2009 operates as an evergreen fund.

5.2.3 The Centre for Drug Design and Discovery

The Centre for Drug Design and Discovery (CD3[39]) brings expert drug discovery capabilities and financial means to academic research groups and small companies in order to translate innovative research into promising drug discovery programs that are well qualified for further development by pharma or biotech companies or by setting up a spin-off company. Supported by LRD and the European Investment Fund, CD3 launched a €60 million fund in 2016.

([38]) As explained in section 1, each association is a network of one university and several associated university colleges.

([39]) Centre for Drug Design and Discovery, http://www.cd3.eu/

5.2.4 Portfolio of investment partnerships

Over the past years, KU Leuven has set up an elaborate set of partnerships and participations as a co-investor in a variety of Venture Capital funds in domains that are relevant for its activities, such as life sciences, advanced manufacturing, chemistry and materials, ICT, etc. This allows to further support the growth of the Leuven ecosystem in general and more specifically of its portfolio of spin-off companies.

5.3 Leveraging the entire community

With the aim to further strengthen the entrepreneurial culture throughout the entire university, including the students and staff, the Lcie (Leuven Community for Innovation driven Entrepreneurship[40]) initiative was launched in 2014. It is largely managed bottom-up with significant student involvement throughout its governance system and supported by a small team that is embedded within the TTO so that it is provided with the autonomy needed to operate.

Lcie has evolved into a university-wide 'brand' of student entrepreneurship with a diverse set of stakeholders. The Lcie initiative is financed through a mix of funding sources. It has been jump-started with a small structural funding from the TTO (including in-kind support via a part-time coordinator) and a yearly allowance of the local network of entrepreneurial startups (Leuven.inc). The funding base gradually increased thanks to support from the local government in setting up and rolling out the student incubator activities, which was then followed by support from private sources. Currently the annual budget is in the order of €200,000 (excluding in-kind "staff time" contributions) and is set to increase in the future. The activities of Lcie focus on three main categories: improving entrepreneurial skills, leveraging the community initiatives, and providing start-up support for entrepreneurial teams.

In section 2 Lcie activities related to curricular aspects of entrepreneurship have been described. Outside the curriculum, a variety of entrepreneurial activities are organised as well. An example is the 'Learning Garages', a modular inspirational format that has been deployed in the university whereby students are challenged to come up with a business case in the field of an emerging technology (e.g. Artificial Intelligence). This concept has been initiated by the Cronos Group - an IT integrator & innovator with focus on entrepreneurship - and one of the strategic partners of the Lcie network. In its implementation, a specific emphasis was placed on attracting students of all backgrounds. In that respect it is noteworthy to mention that a significant share of participants in this concept (at least 1/3) is affiliated with the group of Social Sciences and Humanities. This clearly indicates the potential to reach out to faculties that are often not easily associated with concepts such as 'entrepreneurship' and 'innovation'. It also illustrates well the synergy that arises from forging partnerships with external partners.

5.4 Use of facilities for startups

One of the most valued aspects of university support for student-entrepreneurs is access to facilities such as meeting rooms and workplaces. It was decided to provide facilities for student-entrepreneurs in a decentralized way, across the various campuses. The facilities include a so-called fablab, providing students with the necessary prototyping tools. In addition, students interested in entrepreneurship get access to a creativity lab where they can meet and work on their business plan. Furthermore, students intending to start an entrepreneurial venture can get office space at an incubator facility that is shared with young startup companies so that they can come in contact with peer entrepreneurs.

[40] Note that recently Lcie was re-branded into KU Leuven Kick: https://lrd.kuleuven.be/kuleuvenkick/english/home

5.5 Support for growth of spin-offs

In order to support the further growth of its spin-offs and to leverage the entrepreneurial ecosystem, the KU Leuven has invested substantially in its own science parks and related infrastructure (business centres and incubators) since the mid-1990s. This resulted in the so-called Leuven Technology Corridor[41] consisting of science parks at several locations both in the immediate vicinity of Leuven (Termunck, Arenberg, Haasrode) and further afield (Genk, Tienen).

The Arenberg Science park is located next to the KU Leuven science campus and covers 13 hectares. Ultimately, it will group four building clusters, each offering 25,000m² of working space. Two of these clusters will offer specialised support and facilities in biotechnology; the remaining two clusters will be dedicated to ICT and other high-tech sectors. At present, one ICT-cluster and one biotech cluster are in use.

Box 6. Case studies from the field of engineering.

In 1980, Leuven Measurements and Systems (LMS International) was founded as the first KU Leuven spin-off company. Over the years, LMS International has grown into a world leader in test and mechatronic simulation in the automotive and aerospace industry, as well as in other advanced manufacturing industries. LMS offers engineering solutions that focus on system dynamics, structural integrity, sound quality, durability, safety and power consumption. The company employs over 2,700 people and has branch offices all over the world. In 2012, LMS was acquired by Siemens for a total amount of €680 million.

Research at KU Leuven has also laid the foundations for an important part of the 3D printing industry with the noteworthy examples of its spin-offs Materialise (which went to the stock market in 2014) and LayerWise (which was acquired by 3D systems, also in 2014).

Box 7. Attracting foreign investments.

The KU Leuven science parks play an important role in attracting foreign investments as well as research capabilities. Noteworthy examples are Huawei[42], which established its European Research Institute in Leuven in 2015, and the Japanese multinational Nitto Denko Corporation[43] which moved the location of its European Headquarters to Leuven in 2016, both citing the talent pool in the vicinity of the university as a key factor in their decision.

Internationalization is also an important aspect of the university's policy. In that respect, initiatives have been taken to support the internationalization process of new ventures that spring from the Leuven ecosystem. For example, the university is a founding member of the BelCham[44] incubators in New York and San Francisco. Belcham, or the Belgian American Chamber of Commerce, is a government-independent, not-for-profit organization with the purpose of supporting Belgian excellence in the United States, bringing together students, young professionals, start-ups, scale-ups, and industry-leading corporations. It provides services ranging from office space, networking events, J-1 Visa trainee and internship programs, as well as access to incubator spaces.

[41] https://lrd.kuleuven.be/en/hitech/science-parks-and-business-centres
([42]) https://china.diplomatie.belgium.be/fr/actualites/huawei-announces-launch-its-european-research-institute-eri-leuven
([43])https://www.made-in.be/vlaams-brabant/nitto-vestigt-europees-hoofdkantoor-in-leuven/
([44]) https://www.belcham.org/atelier/

6 Vision and strategy for the near future

In 2018, the KU Leuven presented its new strategic plan, basing the long-term vision for the university on the following 5 pillars:

- Truly International. The transition from a national university with a global reputation to a truly international university
- Future-oriented education. The choice for a future-oriented teaching model based on activation and a corresponding structure of the academic year.
- Going digital. The use of educational technology in a way that facilitates collaborative learning and multi-campus education and broadens the international reach.
- Interdisciplinarity. The development of an interdisciplinary dialogue in addition to disciplinary depth in education, research and public outreach.
- Sustainability. The choice for sustainable management and a commitment to the Sustainable Development Goals in research and education.

A distinctive aspect of the strategic plan is that the five pillars purposefully do not fit within a single policy domain but each of them impacts multiple aspects of the university. Besides the attention it receives in the new strategic plan, **interdisciplinarity** has been a common theme in the university's governance in the past, as highlighted by, for example, the research centres and LRD divisions (section 4), the governance of student entrepreneurship (e.g. the PiP projects, the composition of the Lcie Academy steering committee, section 5) and incubation instruments like CD3 (section 5). Nevertheless, interdisciplinary initiatives and platforms at the university are considered to be still too limited in number and not visible enough, hence the strategic plan aims to further advance interdisciplinary dialogue in the three missions of the university. In that respect, the university envisages to recognise large-scale interdisciplinary platforms as 'institutes', to provide their work on long-term goals and their approach with a more distinctive profile. Examples are the aforementioned Leuven Brain Institute and the Leuven Cancer Institute[45]. Besides fostering scientific interaction as such, interdisciplinarity is also crucial for establishing serendipitous connections of a more entrepreneurial nature across domains. In this sense, the increased support for interdisciplinarity complements existing networking initiatives like Leuven Mindgate (section 2).

Another governance principle that will continue to guide the KU Leuven is the **decentralization of decision-making**, coupled with **centralized support mechanisms**. For example, the LRD research divisions discussed in section 4 are set up by researchers as autonomous vehicles for their technology transfer activities, but receive professional support from the university's centralized TTO services. As another example of how decentralized incentives are coupled with efficiency-enhancing centralization, the Leuven Community for Innovation driven Entrepreneurship (Lcie) coordinates the various entrepreneurship initiatives but is at its heart a student-driven and student-owned initiative.

Also in the future KU Leuven will continue to develop and grow novel platforms and instruments that can further support and enhance the translation of research results into products and services for societal benefit, such as the aforementioned CD3 (drug design), Pharmabs[46] (antibodies), etc....

(45) https://www.uzleuven-kuleuven.be/lki/en
(46) https://www.pharmabs.org/

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List of abbreviations and definitions

A&HCI	Arts & Humanities Citation Index
BOF	Special Research Fund
ECOOM	Expertise Centre for R&D monitoring
EC-RTD	European Commission DG for Research and Innovation
EWI	Department of economics, science and innovation of the Flemish Government
FIT	Flanders Investment and Trade
FWO	Science Foundation Flanders
GBARD	Government budget allocations for R&D
GDP	Gross Domestic Product
GFF	Gemma Frisius Fund
Imec	interuniversity microelectronics center
IOF	Industrial Research Fund
ISCED	International Standard Classification of Education (levels 5-8 correspond to tertiary education, up to and including the doctoral level)
LRD	KU Leuven Research & Development
SCI	Science Citation Index
SSCI	Social Sciences Citation Index
TTO	Technology Transfer Office
VLAIO	Flemish Agency for Innovation and Entrepreneurship

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